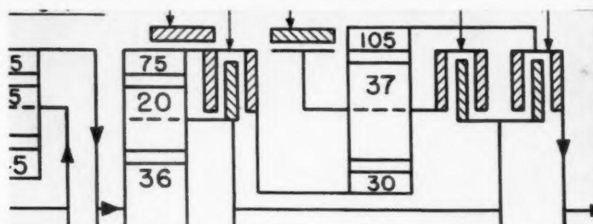
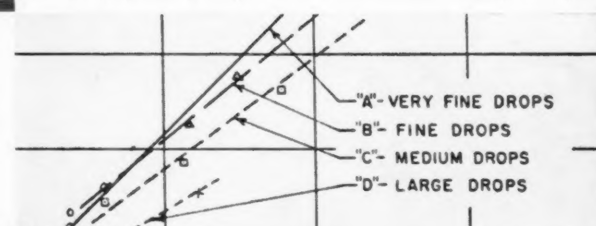
JUNE 1959

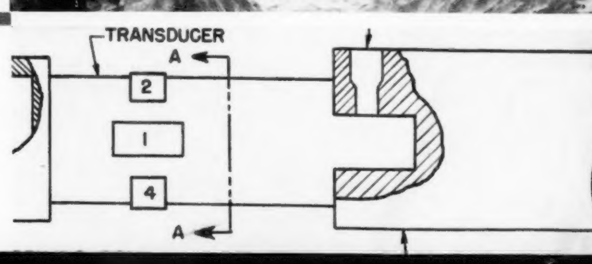
Agricultural Engineering

ASAE

The Journal of the American Society of Agricultural Engineers







Agricultural Engineering

Established 1920

CONTENTS • **JUNE, 1959** • **Vol. 40, No. 6**

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JAMES BASSELMAN, *Editor and Publisher*

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Wheelus Barriensis . . .

To the Editor:

Enclosed is a contribution for your journal. It is submitted, not in impertinence, but in trust that your coverage is broad enough to include it.

DAVID VAN REST
Graduate research assistant
in agricultural engineering
University of California
Davis, Calif.

A Preliminary Investigation Into the Principles of the Mode of Utilization of the Common Wheelbarrow

David van Rest
Assoc. Member ASAE

Introduction

THE wheelbarrow (wheelus barriensis) is an implement whose use has been traced back to ancient Mediterranean civilizations. It consists of a composite of two functionally distinct parts — the wheel and the barrow. From beneath the barrow or material-holding section there project two handles at the end furthest from the wheel. Thus if the wheel is at one end of the barrow, the handles are at the other. An experimental vehicle with the wheel and the handles at the same end was constructed and tested at the University and though it showed some promise in trials it did not, in general, perform as well as the more conventional design. However more work on this question is projected.

The use of two handles is sufficiently persistent to suggest that this number is deliberately selected. When a wheelbarrow is found with only one handle it is usually an indication that the other one has broken off. In a recent survey conducted by the University it was found that over 90 percent of wheelbarrows in general use had two handles.

History and Derivation

The importance of wheels and their size has long been recognized. Even today the expression "He is a big wheel" denotes a high functional capability. The word "barrow" is frequently heard in the form "barrer" itself a small vowel shift from "barrier" suggesting that the implement was formerly used as an obstruction. — Perhaps for herding hogs since a "barrow" is a castrated boar.

Though wheelbarrows feature in a number of legends perhaps the best known is the case of sweet Molly Malone. The expression of her firm determination in the face of oppression and heavy persecution, to "wheel her wheelbarrow through streets broad and narrow, crying cockles and muscles alive — alive — oho" is well known. Note the emphasis on narrow streets. The maneuverability of a wheelbarrow which allows it to operate within such confined spaces as the notoriously narrow side streets of 19th century Dublin, has long been one of its most cherished advantages.

Function

Though instances have been recorded (23)* of wheelbarrows being used for stones (19), gravel (19b), ripe

(Continued on page 344)

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*Numbers in parentheses refer to the bibliography on a sheet of paper which unfortunately has been lost.

Model 209A Krause Wheel Mounted Tandem Disc Harrow equipped with 36 Ingersoll discs.

Ingersoll discs on this Krause Model 310 "Plowing" Tandem Disc Harrow cut big fields down to easy-does-it size.

Report to Readers . . .

THREE-AUGER SILO UNLOADER MAY IMPROVE OPERATING PERFORMANCE

Illinois AES agricultural engineers are developing an idea for a silo unloader that may require less power and have greater capacity. Instead of an unloader using simply a rotating auger or gathering chains to move silage to the center of the silo to be picked up by a blower-thrower and delivered to the unloading chute, these engineers are using three motor-driven augers. A horizontal gathering auger moves the silage to the center of the silo where it is picked up by a 12-in vertical auger which lifts it to a 9-in horizontal auger for delivery to the unloading chute. . . . . Performance of the vertical auger was improved by welding 5/16-in rods at 3-in intervals on the inside of the auger housing and perpendicular to the edge of the auger flighting. The rods, or ribs, reduced rotation of silage about the auger, lowered power requirements, and improved carrying capacity. With the ribbed housing, the vertical auger moved 300 lb of legume silage a minute with a 1-hp electric motor. . . . . Since power requirements for the three-auger unloader are lower, it will have an advantage for use on large-diameter silos. Another advantage is its greater unloading capacity.

ENGINEERS FIND ANSWER TO A MORE STABLE HAY WAFER

One big stumbling block in producing satisfactory hay wafers or pellets is to get the stems and leaves of the hay to hold together after being compressed. Pressure alone is not enough. The hay stems must either be crimped or interlocked, or both, or the hay must be sealed at the edges of the wafer. Sealing, say Cornell agricultural engineers, is accomplished by the increased temperature resulting from the heat of friction produced in the extrusion process. . . . . Hay for the test wafers made by these engineers in a closed-end cylinder was cut from a bale slice. They found that hay cut at a diameter of 3 3/4 in and compressed in a 3 3/4-in cylinder would not form a durable wafer, but if the hay was cut at a diameter of 4 3/4 in and compressed to a 3 3/4-in diameter, crimping of the stems would result and a durable wafer would thus be formed.

PLASTIC COATINGS IMPROVE WEAR RESISTANCE OF TILLAGE TOOLS

Agricultural engineers of the USDA National Tillage Machinery Laboratory have included the use of plastic coatings on the wearing surfaces of tillage implement parts among their various research studies, with some interesting preliminary results. The work thus far has consisted primarily of laboratory screening tests of plastics deemed suitable for the purpose. . . . . Among the thirteen materials that have been screened, the four found to have the highest wear resistance were high-density polyethylene, nylon, rulon, and teflon. Teflon-coated plow bottoms are said to be working satisfactorily in Hawaiian soils, which contain little abrasive material. The Laboratory's tests are continuing.

MECHANIZATION AS ONE KEY TO DISPOSAL OF FARM SURPLUSES

A well-known agricultural engineer advances a unique idea for faster consumption of the mounting farm surpluses - more mechanization. His thought is that advances in mechanization of meat production will do more to help improve the standard of living, as far as red meat is concerned, than anything else. Improvements in feeds and feeding, he believes, might improve production efficiency some 10 to 15 percent, and advances in breeding perhaps an equivalent amount, but that improvements in mechanization should improve individual farmer efficiency by several hundred percent. Therefore, with more farmers producing more beef at lower cost, and more consumers ready and able to buy it, if available at a lower price - well, those mountains of surpluses should then really begin to melt! . . . . Since mechanized production of field crops has contributed to producing these surpluses, what a great idea if it could prove to be an important key to disposing of them.

(Continued on page 312)

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FLE

One in a series of technical reports by Bower

BEARING BRIEFINGS

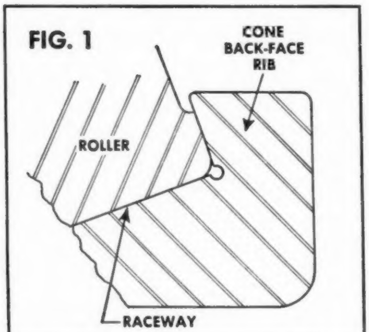
BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

FIG. 1



In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

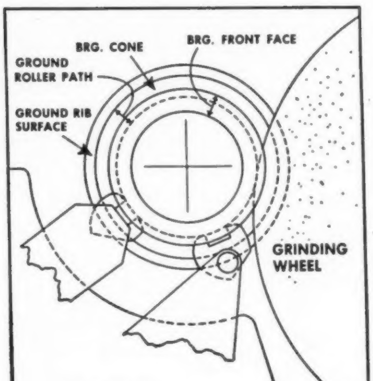
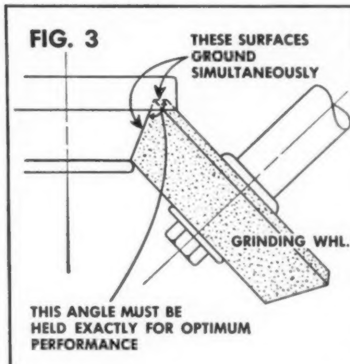


FIG. 2
FRONT VIEW

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and top views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.

FIG. 3



* * * *

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

METAL TUBING IN FERTILIZER DRILLS REPLACED BY NEOPRENE

Ordinary metal tubing never was a satisfactory product for fertilizer drills, both because of the constant flexing and the corrosive action of commercial fertilizers. However, one manufacturer has now developed a fertilizer hose, the basic material of which is neoprene. This new hose not only resists the corrosive effects of even the strongest fertilizers, but also because of its flexibility it has the advantage of long-wear resistance. Its reinforced construction also prevents collapse, and it resists the harmful effects of sun and weather that cause failure of ordinary rubber fertilizer hose. . . . . This new hose, unlike metal tubing, is firmly attached at both top and bottom ends. Then, as the boot opener rides over the ground, the hose stretches and compresses. It is this continual flexing that keeps the fertilizer from caking on the inside walls and eventually clogging the hose.

PLASTIC BUBBLE STRUCTURES FOR TEMPORARY OR EMERGENCY HOUSING

As so often happens in improvising procedures and equipment for conducting research, a Rutgers poultry scientist and agricultural engineer found that a pilot bubble house they built to study heat stress in chickens proved so satisfactory for the purpose that they now see other uses for such structures. These include chick brooders, controlled environment chambers, isolation laboratories cheap enough to burn after housing disease-infected birds, and temporary or emergency housing to facilitate expanding or reducing poultry production depending on market demand. The plastic bubble house built by the Rutgers researchers required a 20x30-ft sheet of polyethylene film that cost $30, a motor-driven blower, and some odds and ends.

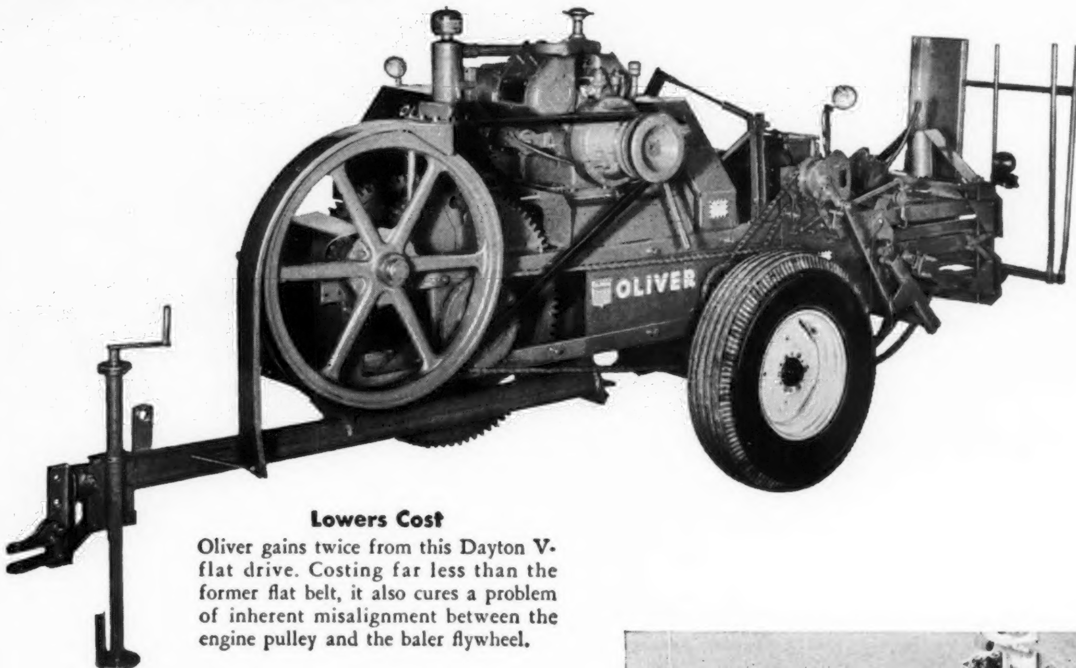
RESEARCH ON MIST SPRAYERS SHIFTS FROM FIELD TO LABORATORY TESTING

For some years Cornell agricultural engineers have been conducting experimental work on orchard and row-crop mist sprayers. Results of their studies thus far indicate that effective control of insect and disease pests is possible with as little as 2 gal of spray per tree and 10 gal per acre. While their research on the experimental sprayers will continue, they are shifting the emphasis from field to laboratory testing in order to obtain more basic information on the mode of mist spray deposit with consequent improvement in spraying efficiencies.

HERRINGBONE LAYOUTS RESULT IN FASTER MILKING IN LESS SPACE

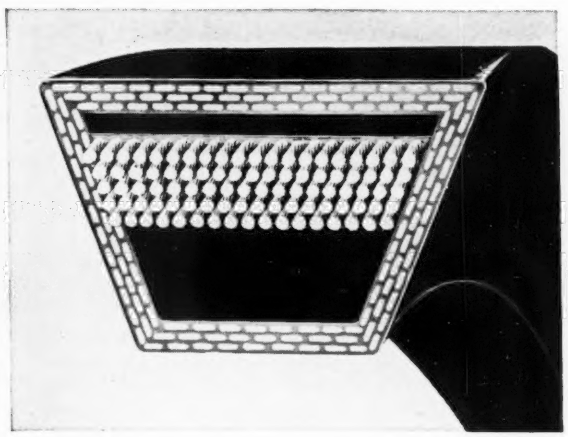
The USDA says that about 1500 dairies in the US have adopted the herringbone milking parlor, a 1957 New Zealand import. Herringbone layouts save space by placing cows in two rows along opposite walls and angled outward about 30 deg as in the herringbone weave. A pit-working area down the center between the rows separates the cows. The closer quarters in this layout reduce operator movements and greatly speed milking. By integrating this layout with pipeline milking and bulk-tank systems, maximum use is made of dairy equipment, and the operator is able to milk more cows or do more chores. . . . . The operator can milk much faster in the herringbone layout than in conventional parlor or stanchion barns since he has to make fewer movements in handling the closely spaced cows. Udders of adjoining cows are separated by an average of a little more than 3 ft, as compared with 8½ ft in conventional parlors. The greatly reduced time of letting cows in and out also speeds up the milking operation. . . . . A herringbone layout large enough to milk 12 cows at a time uses the same type equipment in about the same total space as a conventional milking parlor to accommodate 4 cows. Building costs and costs per stall are about the same for the two systems. Several manufacturers offer herringbone-type equipment and, in some cases, include the building in a package deal. . . . . USDA agricultural engineers are preparing herringbone-layout plans which will be available later this year through state agricultural extension offices.

the Oliver 101



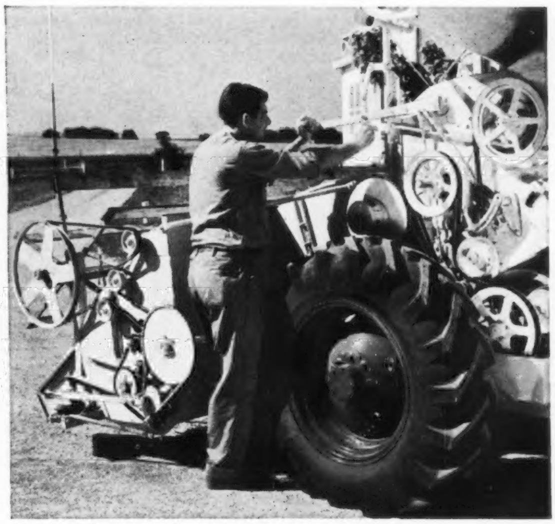
Lowers Cost

Oliver gains twice from this Dayton V-flat drive. Costing far less than the former flat belt, it also cures a problem of inherent misalignment between the engine pulley and the baler flywheel.



Only Complete Line

Here's the Dayton workhorse used most frequently on conventional or V-flat drives for agricultural machinery. For special drives, Dayton offers you a wide choice from the only complete line of V-belts available.



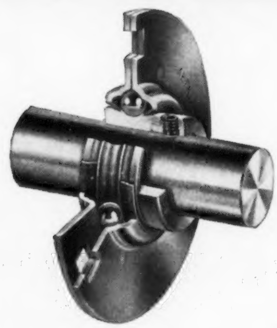
Lab and Field Testing

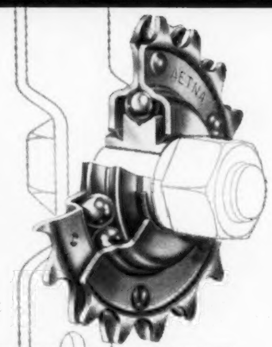
Dayton Agricultural V-belts undergo all types of punishing laboratory tests. The conclusive test is conducted in the field . . . under actual conditions of weather and terrain . . . preferably on the drive for which it's specified.

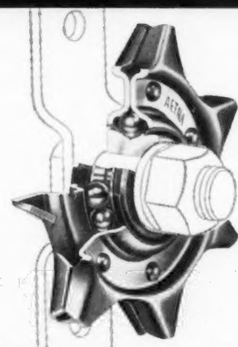
Products Co. A Division of The Dayton Rubber Company, Dayton 1, Ohio

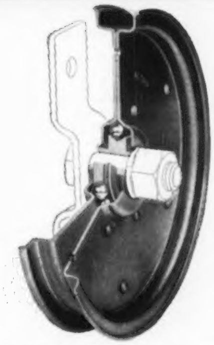
For more information on Dayton Agricultural V-Belts, write, wire, or call the Dayton Agricultural OEM Div., Dayton 1, O.

AMERICA'S MOST COMPLETE LINE

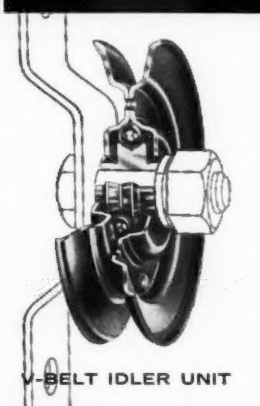

ADAPTER UNIT

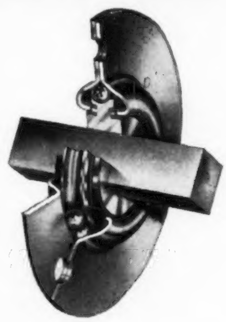

SPROCKET IDLER UNIT
(Single pitch chain type)


SPROCKET IDLER UNIT
(Detachable link chain type)


FLAT BELT IDLER UNIT

OF LOW-COST, PRE-LUBRICATED


V-BELT IDLER UNIT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...their design and application for improved product performance **No. 1**

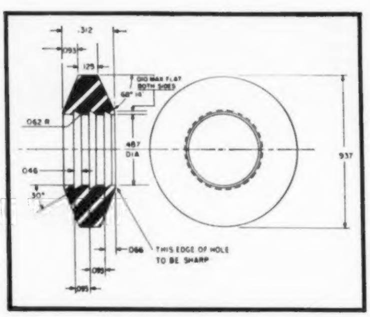
New ORCO continuous process now custom molds precision rubber parts in volume—at less cost!

Precise tolerances within ±0.003 in. are now possible in large volume production of custom-molded rubber component parts. Ohio Rubber's new high-speed, continuous molding process produces such parts at rates of up to 200,000 pieces per day.

Greater precision, which results in important savings on finishing costs, is assured through use of single-cavity, self-registering molds. They permit accurate, uniform application of pressure to minimize flash—maintain consistent tolerances for all dimensions. Uniform material thickness is equally assured by a plasticizing mill, which as an integrated part of the process directs uniform charges to each mold.

Direct feeding, from the mill to the mold wheel, eliminates the conventional intermediate extrusion step and further insures part uniformity and quality consistent with specifications. The continuous process permits *precise* control of time and temperature for each part.

Wide range of parts being more economically produced through Ohio Rubber's new molding process include (top, left to right): valve stem deflector, condenser seal, (bottom) seal piston rod packing, universal joint seal, and oil seal. These, like all the many other small, *precision* parts already produced or being produced, vary in dimensions up to 1½" in diameter and 1" in thickness.



High-precision is indicated in the close tolerances of this quadruple-landed seal for auto shock absorbers—more economically produced in volume through Ohio Rubber's new high-speed, continuous molding process.

Large volume production results in substantial cost savings for small, precision parts requiring tolerances obtainable by other precision molding processes. For parts formed by less precise, conventional methods, performance can be improved through greater accuracy—and without prohibitive increase in cost.

Quantity requirements involving 500,000 or more parts annually are recommended for most advantageous use of the new process. Since two similar parts of different size can be produced simultaneously by alternating the molds on the molding wheel, lower production runs which might not be economical can be combined with a separate order.

Complete information on this revolutionary new process is available in bulletin form. Send for your free copy today. At the same time, be sure to inquire about Ohio Rubber's complete component "Customeering" service—molding, extruding, and bonding-to-metal. Just mention ORCO Bulletin 715.

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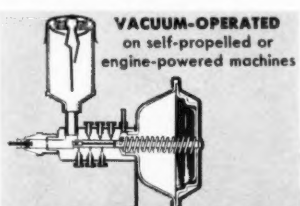

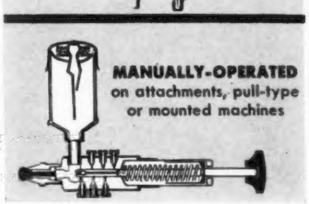

Lincoln's Multi-Luber System permits lubrication while machine is operating. Vacuum-type Systems are actuated simply by pushing a button on the implement dash panel; manual-type systems are actuated by pushing a conveniently located knob.

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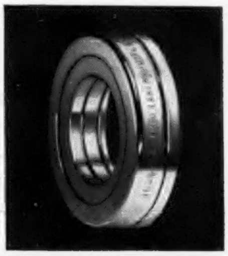
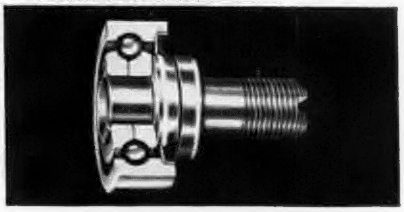
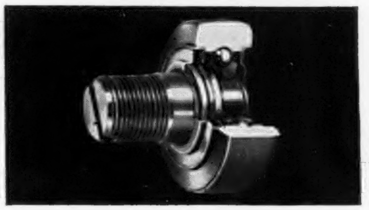


Clutch Bearings



Hay Rake Bearings

Idler Pulley Assemblies



Plunger Rollers

Agricultural Engineering

June 1959
Number 6
Volume 40

James Basselman, *Editor*

Farm Equipment Industry Prospects Good

CURRENT prospects of farm equipment industry will hold steady says the Value Line Investment Survey in a new report released June 1. Following are statements taken from that report:

"Although farm income is declining this year (due to the leveling off in farm prices, in the face of a continued rise in the cost of the supplies and equipment the farmer buys), the dollar value of farm equipment purchases is expected to hold steady for the next 12 months at least. Sales are currently running well ahead of the 1958 period, on the strength of last year's sharply higher farm income. Farmers are spending a rising proportion of their income on new machinery, prices are higher, and acreage idle last year under the soil bank program is being returned to use this year, necessitating the use of more equipment.

"At the same time, cost reduction efforts are boosting the earnings of the individual equipment manufacturers. Last year's results did not fully reflect management's success along these lines.

"Over the next 3 to 5 years, the need to provide for an increasing population on virtually the same amount of land should give rise to greater purchases of more efficient equipment. Bigger and more versatile farm machines now under development by the industry promise to make possible further substantial farm operating economies. Also, the large number of machines bought in the early post-war years will create a growing replacement demand in the years ahead. Prospects appear favorable for the farm equipment industry, in the generally favorable economic environment probable during the next several years."

The report revealed that the Value Line Investment Survey sees most of the farm equipment stocks as better-than-average holdings for the coming year. And that they appear even more attractive for accounts seeking Appreciation Potentiality to 1962-64. As a group, they rank farm equipment stocks in the top 20 percent of all stocks in this regard.

Engineering Enrollment Down

FOR the first time in seven years, and despite still-critical demands for engineering talent, enrollment in American engineering schools is on the decline, according to a report by the American Society for Engineering Education.

The following engineering enrollment figures were obtained in an annual official survey of students and degrees conducted by the American Society for Engineering Education in cooperation with the U.S. Office of Education, and reported by Justin C. Lewis, Head of Higher Education Statistics, and Dr. Henry Armsby, Chief for Engineering Education, both of the U.S. Office of Education:

The 153 accredited American engineering colleges had 2.9 percent less students in the fall of 1958 than in the fall of 1957. The freshman class which entered last fall was 11.6 percent smaller than 1957, with an enrollment of 59,164 instead of 67,017.

Declining enrollments have not yet affected the number of engineering graduates, which number 31,216 in 1957-58 compared with 27,748 the previous year. But the numbers are far short of the record graduation of eight years ago, when World War II veterans were finishing their delayed college careers.

Fears of dropping engineering enrollments were confirmed by the official figures. Engineering students are now less than 7.7 percent of all American college students, compared with nearly 8.5 percent in 1957. Enrollment of second-year students is down 6 percent from last year, and third-year students are down 4 percent. Only through the fourth and fifth-year category does the 1958 enrollment total as large as in 1957. This gives promise of more graduates in June 1959; but there may be fewer in the years thereafter.

Graduate study in engineering continues to increase sharply, according to the report, and enrollment is now at record levels. A total of 27,456 students were enrolled in master's degree programs in the fall of 1958, an increase of 14.7 percent over 1957, and 4,762 were studying for doctor's degrees, an increase of 14.3 percent.

Last year 5,751 master's degrees were given in engineering, nearly 10 percent of the master's degrees given in the United States during the year. There were 653 doctor's degrees in engineering, or 8 percent of doctor's degrees given in all fields.

Transactions of the ASAE

THE second edition of the TRANSACTIONS of the ASAE will be off the press in July or early August. Original plans for publishing before June were changed to provide a more even distribution of the publication work load during the early part of the year.

The first edition, consisting of 96 pages, was mailed to all members of ASAE and subscribers of AGRICULTURAL ENGINEERING in the fall of 1958. The second edition will contain at least 128 pages of technical agricultural engineering papers and is being offered for $5.00 ($2.50 to ASAE members). Also, a limited supply of the first edition is still available at $4.00 per copy. If you have not ordered the second edition as yet, a limited number of copies resulting from a normal overrun will be available. Send your order to ASAE, 420 Main St., St. Joseph, Mich.

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Evolution in Tractor Transmissions

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Basic design characteristics, operating advantages, and possible combinations of all-planetary-gear transmission systems

THE ever-increasing variety of equipment used with both farm and industrial wheel-type tractors has created a demand for more speeds in the transmission and a greater range or spread of travel speeds. Certain operations in both agricultural and industrial fields require a low speed of 1 mph or less at governed engine speed. Also increased crop yields due to heavier fertilization have in many cases dictated slower harvesting speeds. On the other hand, higher speeds have come into use for certain work such as mowing, cultivating and hauling, and road travel.

Thus four or five speeds in a transmission do not provide a sufficient range of ratios for a wheeled tractor. The lower speeds are too fast for many uses, and the top speed is either too slow or there is too large a gap between speeds.

The need for transmissions having eight, 10 or 12 speeds that can be changed with finger-tip controls is producing a new revolution in tractors. With fewer than eight speeds, a converter can be used to increase the effective range and, at the same time, smooth out the larger steps between speeds.

Since the speed range of a track-type tractor is much smaller, three to five speeds are usually sufficient especially when a torque converter is used, but speed changes without power interruption is much needed here also.

Combined Planetary and Countershaft Gears

A partial solution has been made in some tractors by using a two-speed planetary power-shift gear unit ahead of an existing sliding-gear countershaft transmission. The tooth loads in the transmission gears are increased in the medium and faster speeds which were unable to slip the drive wheels without additional reduction. However, maximum loads will not be increased in the lower speeds which do slip the drive wheels. When traction is increased by wheel weights or mounted equipment all the transmission and final drive gears may be loaded more heavily than before and safety factors must be figured accordingly.

A lever-operated friction clutch is provided for locking the planetary gears in a one-to-one direct drive, but whenever this clutch is released at any speed, a one-way roller brake automatically holds a reaction member, thus bringing the added planetary reduction into operation without interruption of power and, at the same time, increases drawbar pull about 45 percent.

A planetary with a larger reduction ratio can be used as a range gear. This is placed behind the main transmission and is shifted manually. The clutch pedal and hand lever are used for gear shifting.

Combined Torque Converter and Countershaft Gearing

A second method of increasing the speed range and torque output of existing countershaft units is the combined torque converter and countershaft gearing. A friction clutch must still be used to obtain complete disengagement to permit changing gears. A second clutch is used to lock out the converter when extra pulling power or extra speeds are not required. The converter automatically comes into operation whenever the lockout clutch is released manually. Smooth pickup of heavy loads is an advantage of the converter but is obtained at the price of increased fuel consumption. While users have benefited greatly from the various improvements cited above, they must all be considered as temporary compromises in the long range view.

Automobile Transmissions in Tractors

While the use of automobile transmissions in tractors is a possibility, the problem of adapting such units to tractors appears impractical. After adding a range gearset, PTO gears, and another reduction to obtain proper ratios, the results would cost more than a transmission designed specifically for tractor requirements.

On the other hand, certain individual automobile gears, clutch plates, brake bands, hydraulic components or other small parts can be used in tractor design. It is often more profitable to purchase such parts produced in high volume than to tool up for a smaller volume for tractors.

Full Power Shifting

In the author's opinion full power shifting in all speeds will eventually become conventional as it already has in automobiles. There is no need for automatic speed changes, however. The ability to do more work with on-the-go shifting and the added convenience and ease of operation outweighs a somewhat higher cost, in the mind of most users. As more experience is gained, designs can be simplified to get costs down.

All-Planetary Transmission

Planetary gears lend themselves readily to power shifting and are adaptable to produce any desired number of speeds in a compact unit. Unlike conventional countershaft gearing, planetaries can be readily arranged to produce a desired gear reduction, and then the same gears can be coupled in other ways in the same transmission (by means of one or more clutches), to obtain several other gear ratios. This imposes limitations on the ability to obtain exact ratios desired in all speeds, but if small compromises can be made, a gear combination can be selected from the many available which can be made to conform.

Paper presented at a meeting of the Quad City Section of the American Society of Agricultural Engineers at Davenport, Iowa, April, 1956, and revised February, 1959.

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No Master Clutch Required

The hydraulically operated clutches in the transmission itself are used for starting the tractor and for speed changing. A certain amount of slippage in the clutches and brake bands, when starting heavy loads, permits smooth starts since starting will usually be in one of the lower speeds. Speed changes under heavy loads are also smooth because, with eight to 12 speeds, the steps between speeds are comparatively small.

Under light loads, however, starting and shifting may be rough as the clutches and brakes engage with less slip. This problem is solved by adding a valve for feathering oil pressure to the clutches and brakes. It can be foot-operated to leave the hands free for steering. This also facilitates inching the tractor.

A spring-loaded, friction-disk coupling between the engine and transmission also contributes greatly to smoothness by eliminating peaks of torque due to sudden changes of load.

Such a coupling transmits maximum engine torque at uniform speed without slippage, but slips slightly when momentary overloads occur reducing shock loads on the transmission, final drive, implement, and, most important of all, on the operator. In some types of work the unequalled smoothness of a torque converter may be preferred, especially if the range of speeds in the transmission is not large and if fuel economy is of secondary importance.

High Torque Capacity of Planetaries

Large torque capacity can be obtained with very small planetary gearsets because the load is divided between three or more planets. Besides two or more planetary sets on the same axis can be coupled in parallel relationship to further split the power being transmitted. Thus, two planetary sets (each with three planets) arranged this way split the power six ways, and the torques multiplied independently at each gearset are added together at the common output shaft. Planetaries are also high in mechanical efficiency. (This is analyzed in the appendix to this paper.)

Simple Planetary Gears Preferred

Simple planetaries consisting of a sun gear, planet gears and a ring gear, have the tooth loads ideally balanced because all are in the same radial plane. These are not only best for this reason, but they are more easily coupled to obtain multispeed combinations. Planetaries without internal ring gears have unbalanced loads which tend to push the planets out of mesh with their sun gear. Other types using internal ring gears, but with dual planets in the same plane or with long and short planets meshing with two sun gears and one ring gear, are usually more expensive and less efficient and tooth loads are not balanced as in simple planetary sets.

Nearly all the planetary transmissions introduced in recent years for tractors, trucks and cars employ these simple planetaries. Likewise heavily loaded planetaries used as auxiliary reductions in truck axles, such as produced by Timken, Clark and Eaton are of this simple type. The only loads not balanced out are those on the planet pinions, but these rotate on efficient inexpensive needle bearings on short pins fixed at both ends in the planet carrier for ideal straddle support.

The accompanying diagrams represent the evolution in transmissions using simple planetary sets exclusively. They are side views, in section, of the upper half only. Consequently only one planet pinion per set is shown. The numerals denote the number of teeth in the gears. The clutches are indicated by three radial disks or plates, and the brakes by a horizontal rectangle to represent a section through a brake band which can be contracted onto a drum to hold a reaction member stationary.

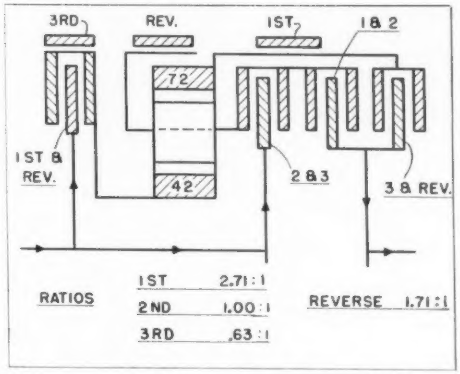


Fig. 1 Three speeds and reverse with a single planetary

Although disk brakes are often used, they are shown in the following sketches as contracting bands, to distinguish them readily from the clutches. The clutches and brakes are shown in released positions, with a legend indicating speeds in which each is engaged.

One approach, when designing a transmission, is to use a separate planetary set for each speed and a brake for holding one member of each as a reaction member. While this eliminates the use of clutches, except for one to lock up the whole unit in direct drive, it is impractical, as many gearsets and reaction brakes are required. Besides, the gears not working in each speed usually idle at excessive speeds.

The opposite approach is to use few gears and obtain as many speeds as possible. Fig. 1, for instance, shows a single gearset arranged to produce three speeds forward and one reverse, the top speed being an overdrive. While this shows four ways of using a single planetary in one unit, it is impractical as it requires seven friction elements (clutches and reaction brakes).

By using two planetaries, we can use each individually as in Fig. 1, and they can also be coupled in com-

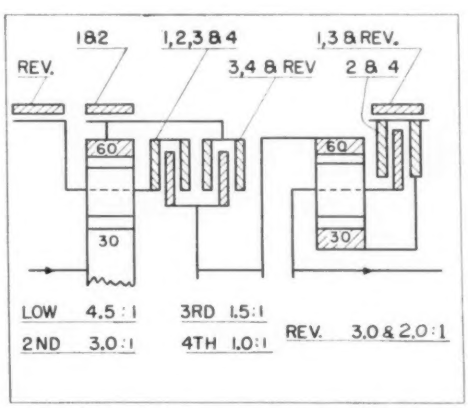
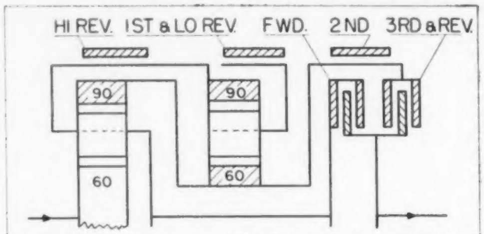


Fig. 2 Four forward and two reverse ratios with two planetaries



	1	2	3	LO REV	HI REV
RATIO	4.75	2.5	1.0	3.2	1.5
MPH	1.5	2.8	7.0	2.2	4.7

$1ST = \left(\frac{90}{60} \times \frac{90}{60}\right) + \frac{90+60}{60}$ $\quad 2 = \frac{90+60}{60}$ $\quad LO\ REV = \frac{90}{60} + \left(\frac{60}{90} \times \frac{90+60}{60}\right)$

3RD = DIRECT DRIVE = 1.0 $\quad$ HI REV = $90 \div 60 = 1.5$

Fig. 3 Three speeds forward and low and high reverse

pound. Fig. 2 shows four speeds and reverse produced this way. Here again too many clutches and brakes are required.

Obviously we must find more ways to use the gearing and combine them all in one transmission. Starting with two simple planetary gearsets, each set can be used separately as in Figs. 1 and 2.

Next they can be coupled together either in series, in parallel or in opposed relationship. When in series the torques from each gearset are multiplied together; in parallel they are added, and in opposed relationship one is subtracted from the other. By using one or more of each of the above methods in the same transmission, many speeds can be obtained with two or three planetary sets. Following are examples:

Fig. 3 shows a three-speed unit with a low and high reverse, with typical reduction ratios and corresponding miles per hour. This might be adaptable to a track-type tractor with a torque converter.

In low the two planetaries are coupled in parallel with part of the output torque flowing from each. Likewise, in low reverse each gearset contributes a fractional part of the total reverse torque. This unit has high-torque capacity because of the above. In second and high reverse, respectively, only that portion of the low and low reverse torque produced by the front gearset is used.

To start in low, the middle band and front clutch are engaged. This front clutch then remains engaged in all three forward speeds. Likewise the rear clutch engages and remains engaged for both reverse speeds.

Clutch Design and Location

Clutches are usually of the multiple-plate type in oil with the plates separated only 0.010 to 0.020-in. when released. A small drag torque exists due to shearing of the oil because the driving and driven plates rotate at different speeds when released. High relative or differential clutch-plate speeds can cause excessive heating and drag. In passenger cars plate differentials equal to twice input speed can be tolerated in first speed, because the car is seldom used in this speed for long periods. In a tractor, however, this should be avoided by locating the clutch at some point where the plate differential rpm does not exceed that of the engine in any forward speed.

Often when the clutch-plate differential is less than 100 percent of input speed when open, the clutch must transmit more than 100 percent of input torque when engaged. Clutches can be kept small and compact in spite of this by the use of sintered bronze facings which permit high pressures.

In reverse speeds much higher plate differentials are practical, especially for wheeled tractors.

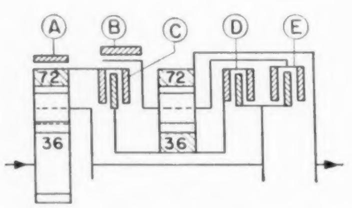
Clutch plate drag is small in Fig. 3 because the relative speeed of the clutch plates is only 53 percent of input speed in low, 40 percent in second and zero in third.

In Fig. 4 there are four forward speeds and two in reverse which also could be used advantageously in a tractor requiring a slow and fast reverse. There are no gears idling in any forward or reverse speed. As in Fig. 3, there is no danger of clutches overheating if properly lubricated because the plate differential of open clutches is only 50 percent of input in low, 33 percent in second and third, and zero in fourth. In this design it will be seen that the two gearsets are compounded (coupled in series) in three different ways in first, third and low reverse, respectively, while the front set only is used for second and R2.

Table 1 shows which friction elements are engaged in various speeds. Note that the speeds are obtained with fewer friction units than in Fig. 2.

For six forward speeds and two in reverse, three planetaries may be used as in Fig. 5. In this a 4-to-1 range gear is used behind a three-speed and reverse combination. Typical ratios and speeds are shown.

In low and fourth speeds the first two planetaries are coupled in parallel at which time the middle clutch transmits the output of the front set (1.56 times input torque)



SPEED	1	2	3	4	R1	R2
RATIO	4.0	3.0	2.0	1.0	6.0	2.0
MPH	2.0	2.67	4.0	8.0	1.33	4.0

$LO = \frac{72}{36} \times \frac{72}{36} = 4.0$ $\quad 2ND = \frac{72+36}{36} = 3.0$

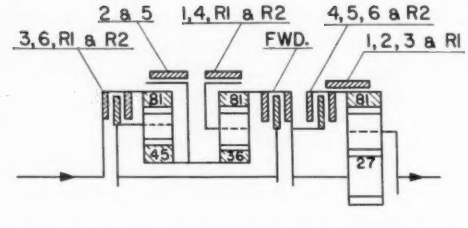
$3D = \frac{72+36}{36} \times \frac{72}{72+36} = 2.0$ $\quad$ 4TH = DIRECT DRIVE

$R1 = \frac{72+36}{36} \times \frac{72}{36} = 6.0$ $\quad R2 = \frac{72}{36} = 2.0$

Fig. 4 Four speeds forward and low and high reverse

SPEEDS	1	2	3	4	R1	R2
BRAKES		A	A		A	
	B				B	B
CLUTCHES	C		C	C		C
		D		D	D	D
	E	E	E	E		

Table 1 Brakes and clutches applied in each speed in Fig. 4



SPEED	1	2	3	4	5	6	R1	R2
RATIO	11.25	6.2	4.0	2.81	1.56	1.0	9.0	2.25
MPH	1.3	2.4	3.75	5.3	9.6	15.0	1.6	6.6

$1ST = \frac{81+45}{81} + \left(\frac{45}{81} \times \frac{81}{36}\right) \times \frac{81+27}{27}$	$2ND = \frac{81+45}{81} \times \frac{81+27}{27}$
$3D = 1.0 \times \frac{81+27}{27}$	$4TH = \frac{81+45}{81} + \left(\frac{45}{81} \times \frac{81}{36}\right)$
$5TH = \frac{81+45}{81}$	6TH DIRECT DRIVE
$R1 = \frac{81}{36} \times \frac{81+27}{27}$	$R2 = \frac{81}{36}$

Fig. 5 Six speeds and two reverse with 4:1 range gear

to the 27-tooth rear sun gear, while the second planetary output (1.25 times input) passes directly to the rear sun gear. Thus in low, the front set produces 55 percent of the primary torque multiplication and the second set 45 percent. The rear set produces the secondary multiplication.

The plate differential of the front clutch is 64 percent of input speed in first and fourth, 36 percent in second and fifth, and zero in third and sixth. The middle clutch is released in both reverse speeds and has a plate differential of 144 percent. The differential of the rear clutch is 36 percent in low, 64 percent in second, 100 percent in third, and zero in fourth, fifth and sixth. In third and sixth speed input torque is transmitted directly to the rear planetary through the first two clutches with no load on the teeth of the first two planetaries.

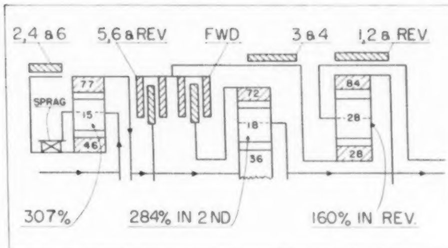
Advantages of Overdrive

Fig. 6 shows six speeds with an overdrive splitter located ahead of the main gears. The sun gear of the overdrive is held by a brake, and whenever the brake is released a one-way sprag or roller clutch automatically puts the overdrive in a one-to-one drive. The overdrive speeds up the other gears but not excessively, because the engine governor keeps the input rpm moderate. Only certain ratio combinations lend themselves to this type of arrangement, however.

The advantage is that maximum torques are reduced in the rest of the transmission and in at least the first reduction in the final drive. To compensate for this the reduction in the final drive must then be larger.

The overdrive, placed ahead, is not subject to reverse torque and thus can use a one-way clutch. This not only provides perfect timing of half the speed changes but also simplifies the hydraulic system by replacing a plate clutch and its controls. The fact that the one-way clutch causes freewheeling in half the speeds can hardly be considered serious since the remaining ones are adequate for downhill engine braking.

Planet speeds should be considered when using an overdrive, but if it is coupled to the sun gear of the next gearset



	1	2	3	4	5	6	REVERSE
RATIO.	9.0	5.63	3.0	1.88	1.0	.626	3.0
MPH.	1.0	1.6	3.0	4.78	9.0	14.4	3.0

$1ST = \frac{72+36}{36} + \left(\frac{72}{36} \times \frac{84}{28}\right)$	$3RD = \frac{72+36}{36}$	$6TH = \frac{77}{77+46}$	$REV. = \frac{84}{28}$

Fig. 6 Six speeds and two reverse with overdrive splitter

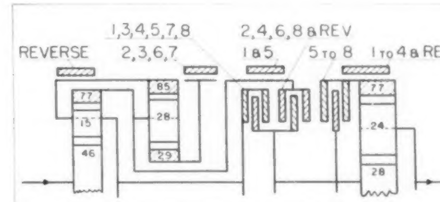
(instead of a ring gear), speeds will not ordinarily be excessive. Note that the maximum speeds of the planets as shown in Fig. 6 are less in the second and third gearsets than that in the overdrive itself, where it is 307 percent of input, or 6140 rpm at 2000-rpm engine speed.

While this may seem high at first glance, the small diameter of the 15-tooth planets brings pitch line velocity to 1720 fpm for 14-pitch teeth which is no more than occurs in countershaft transmissions. Since planet pin bearings are small in diameter and can be well lubricated, relatively high planet speeds are practical. Helical teeth should be used to keep the gears quiet. A helix angle of 10 to 15 deg is adequate and does not introduce large end thrust loads.

Eight-Speed Designs

Fig. 7 shows an eight-speed-two-reverse combination with typical ratios and speeds. Only the slow reverse ratio is shown. The clutches and brakes engaged for the various speeds are indicated by the numerals. The two front planetaries produce four speeds and reverse, and the rear set the low range. The first planetary produces fifth and high reverse and the primary reduction for first and low reverse.

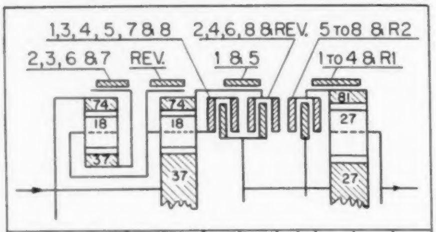
In second, third, sixth and seventh, the first two planetaries are coupled in opposed relationship as indicated by the minus sign in the ratio formulas. In second and sixth, the backward torque of the front ring gear subtracts from the forward torque produced at the second set planet carrier. In third and seventh, reverse torque at the second carrier subtracts from forward torque produced at the front carrier.



	1	2	3	4	5	6	7	8	REV
RATIO	10.0	7.2	5.3	3.75	2.7	1.9	1.4	1.0	6.3
MPH	1.0	1.4	1.9	2.6	3.7	5.2	7.0	10.0	1.6

$5TH \ \frac{77+46}{46}$	$6TH \left(\frac{85+29}{85} \times \frac{77+46}{46}\right) - \frac{77}{46}$	$7TH \ \frac{77+46}{46} - \left(\frac{85}{85+29} \times \frac{77}{46}\right)$
8TH = DIRECT	RANGE GEAR $= \frac{77+28}{28} = 3.75$	REV $3.75 \times \frac{77}{46} = 6.3$

Fig. 7 Eight speeds and two reverse with 3.75:1 range gear



SPEED	1	2	3	4	5	6	7	8	R1	R2
RATIO	12.0	8.0	6.0	4.0	3.0	2.0	1.5	1.0	8.0	2.0
MPH	1.25	1.88	2.5	3.75	5.0	7.5	10.0	15.0	1.88	7.5

$5TH = \frac{74+37}{37}$	$6TH = \frac{1.00}{\left(\frac{74}{74+37} \times \frac{74+37}{74}\right) - \frac{37}{74}}$	$7TH = \frac{74+37}{74}$
8TH = DIRECT	$\text{RANGE GEAR} = \frac{81+27}{27}$	$R2 = \frac{74}{37}$

Fig. 7A Eight speeds and two reverse with 4.0:1 range gear

Fig. 7A shows an eight-speed design with many of the characteristics shown in Fig. 7 but lower in cost because the first two planetary sets can be smaller in diameter and identical as to number of teeth. The planet speeds are low in all the gears that are working. The front planet idles under no load in first and fifth however at 274 percent of input speed, and at 410 percent in reverse. Since the set is idling this is satisfactory. The maximum clutch plate differential occurs in fourth speed only in both Figs. 7 and 7A when it is 100 percent of input speed. Ratio computations for the high-range speeds are shown. In the low range these are multiplied by 4.00.

Fig. 8 is another eight-speed design with reverse ratios of 8.4 and 1.64 to 1. The low reverse ratio only is shown. A large speed range of 1 to 20 mph is provided. The two clutches are at the front end where they never carry more than 100 percent of input. The maximum clutch plate differentials occur in fourth, eighth and reverse, where they are 100 percent of input. Ratio computations for the top four speeds are shown, and in the low range these are multiplied by 5.10.

Fig. 9 is a diagram of a ten-speed transmission. Typical gear ratios and corresponding travel speeds are shown. An overdrive is used ahead of a five-speed and reverse planetary combination. It is engaged by applying brake *A*, which holds the sun gear stationary against its tendency to overrun, and causes the ring gear to speed up instead. When the brake is released, the sun gear tries to overrun the planet carrier but is held by a one-way clutch located between the sun gear and carrier which locks up this set in direct drive. The ratios are computed as shown.

Fig. 10 shows the torque paths in each speed. To simplify this diagram for clarity, the clutches are all omitted and only the brake bands that are engaged are shown.

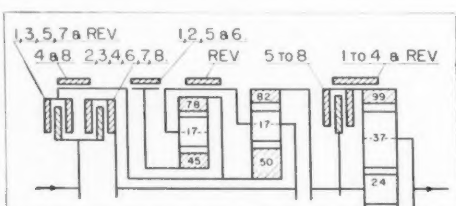
Table 2 shows the friction elements engaged in Fig. 9 in each speed.

CLUTCHES & BRAKES ENGAGED IN EACH SPEED													
		1	2	3	4	5	6	7	8	9	10	R1	R2
BRAKES				A	A			A	A		A		A
						B	B	B	B				
		C	C	C	C							C	C
CLUTCHES										D	D	D	D
			E		E		E		E	E	E		
		F		F		F		F					

Table 2 Clutches and brakes applied in each speed in Fig. 9

In all the speeds shown on the left-hand side of Figs. 9 and 10, the overdrive is clutched into direct drive by the one-way clutch. In the speeds on the right-hand side, the overdrive speeds up the other gears 60 percent.

In first and third speed the rear carrier is held by brake C and the arrows show a parallel torque path through the middle and rear planetaries, with the middle planetary contributing 30 percent of output torque and the rear planetary 70 percent. The 70 percent portion is used separately for second and fourth speeds and the 30 percent portion is used separately to produce fifth and seventh. In second and fourth the middle and rear carriers are both held as reaction members by brake C. Brake B holds the middle ring and rear sun gear in fifth, sixth, seventh and eighth.

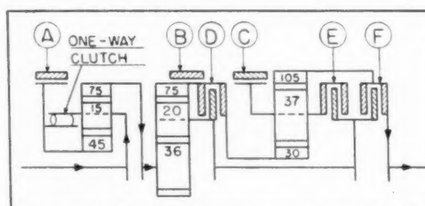


	1	2	3	4	5	6	7	8	REV
RATIO.	12.5	7.9	5.1	3.2	2.4	1.54	1.00	.622	8.4
MPH.	1.0	1.6	2.4	3.9	5.1	8.0	12.4	20	1.5

$5TH = \left(\frac{78}{78+45} \times \frac{82+50}{82}\right) - \frac{50}{82} = \frac{1}{2.4}$	$6TH = \frac{82+50}{82} - \left(\frac{78+45}{78} \times \frac{50}{82}\right) = \frac{1}{1.54}$

7TH = DIRECT	$8TH = \frac{82}{82+50}$	$\text{RANGE GEAR} = \frac{99+24}{24} = 5.1$	$REV = 5.1 \times \frac{82}{50} = 8.4$

Fig. 8 Eight speeds and two reverse with 5.1:1 range gear



SPEED	1	2	3	4	5	6	7	8	9	10	R1	R2
RATIO	10.4	7.3	6.5	4.6	3.1	2.4	1.9	1.5	1.0	.625	3.5	2.2
MPH	1.1	1.5	1.7	2.5	3.6	4.7	5.8	7.5	11.2	18.0	3.2	5.1

1	$\frac{75+36}{36} + \left[\frac{75}{36} \times \frac{105}{30}\right] = 10.375$	3	$.625 \times 10.375 = 6.484$
2	$\frac{75}{36} \times \frac{105}{30} = 7.292$	4	$.625 \times 7.292 = 4.557$
5	$\frac{75+36}{36}$ ------- $= 3.083$	7	$.625 \times 3.083 = 1.927$
6	$\frac{75+36}{36} \times \frac{105}{105+30} = 2.398$	8	$.625 \times 2.398 = 1.499$
9	DIRECT DRIVE = 1.00	10	$\frac{75}{75+45} = .625$
R1	$\frac{105}{30} = 3.50$	R2	$.625 \times 3.50 = 2.188$

Fig. 9 Ten-speed transmission

The rear planetary idles slowly without load in fifth and seventh, but in sixth and eighth it acts as an overdrive to speed up fifth and seventh, thus producing sixth and eighth. Thus in eighth speed both the front and rear planetaries function as overdrives. In ninth and tenth the two rear planetaries are in direct drive with locked-in torque paths shown by the arrows.

In the reverse speeds, the middle planetary rotates as a solid unit which, in R1, provides a direct drive to the 30-tooth rear sun gear. Since the rear carrier is held by brake C, the rear ring gear is then forced to turn backward.

The maximum torque on the clutches is about three times input torque which results in low clutch plate differential speeds, the highest being 77 percent of input in clutch D in fourth speed. This avoids undue clutch drag. The planet speeds are also moderate, the highest being 288 percent of input speed at the middle planetary when in fourth speed.

Twelve forward speeds can be obtained in this gear train by adding another clutch. Also two extra low reverse speeds can be obtained if desired by the same method. Different ratios can of course be obtained by varying the number of teeth.

Power Take-Off

One of the many advantages of the all-planetary transmission is that the PTO is independent without requiring an independent PTO shaft direct from the engine, such as is required with sliding-gear transmissions. Also, since hydraulic pressure is available, a hydraulically operated PTO clutch with easy control is used. This eliminates the need of a double master clutch for two-stage clutching as often used with countershaft transmissions.

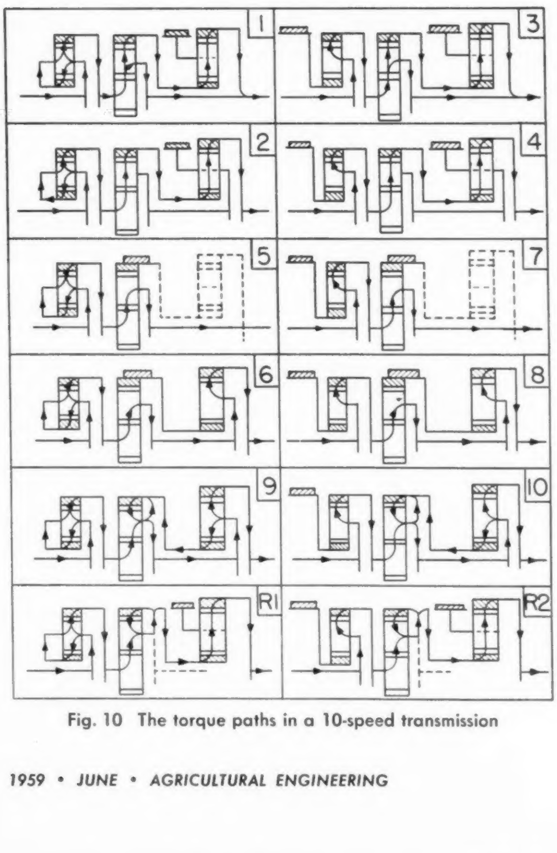


Fig. 10 The torque paths in a 10-speed transmission

Summary

Some basic characteristics of planetaries have been described at some length in this paper, in the hope that it will be of value to tractor engineers. Many other combinations could be described if space permitted, but the above are typical examples.

Although planetaries are increasing in popularity, countershaft gearing will continue to be used in many automotive units, especially where an offset or drop box is required, as for instance in special purpose tractors and road graders.

APPENDIX

Planetary Gear Efficiency

The following eight factors, present in simple planetaries, greatly improve their mechanical efficiency as compared with that of countershaft gears.

1 Balanced tooth loads. Since the separating forces all cancel each other, there are no forces to move the teeth out of mesh and proper tooth contact is maintained from zero to maximum load.

2 No loads on the shaft bearings except the weight of the rotating parts and consequently shaft deflections are negligible. This reduces friction loss.

3 Tooth contacts are not disturbed by bearing wear at the main shafts or at the planet pinions.

4 Fine pitch gears can be used because of divided tooth loads. These are more efficient than coarse gears because tooth contact is confined close to the pitch line of the gear where sliding action is very low.

5 Light weight oil used with planetary gears reduces drag losses especially when cold. Also since pressure lubrication is used the loss due to churning of the oil is eliminated.

6 Drag loss of idling gears is reduced since part or all of the gears and clutches are locked up to turn as a solid unit in some speeds.

7 Half of the meshes are with internal gears. These are more efficient than external gears, because of their enveloping geometry which results in a more gradual meshing of the mating teeth of the planet pinions as they roll around inside the internal gear.

8 Planetary action (planetation). This is the most important factor of all. Whenever the planet carrier of a simple planetary rotates in the same direction as the input sun gear (or ring gear), the tooth-engagement speed is less than the actual pitch line velocity, because the planet pinions are turning around the main axis with (but more slowly than) the input gear. Since horsepower is torque times speed, the horsepower being transmitted at a tooth mesh is reduced if the tooth engagement speed is reduced by planetation. The horsepower is then less than the horsepower passing through the gearing. This does not mean that part of it disappears, but that a fraction of the power is transmitted by the gear teeth and the rest by planetation.

Fig. 11(A) shows a planetary set with ring input, sun-gear output, and the carrier held stationary. With an input of one unit of torque at 100 rpm we have an input horsepower of $1 \times 100 = 100$ percent. Since the relative speed of the ring and carrier is 100 rpm, the horsepower at the ring gear mesh is also $1 \times 100 = 100$ percent of input.

In Fig. 11(B) the sun gear is held stationary instead of the carrier. The input torque is again 1.0 at 100 rpm, but the carrier turns at 67 rpm instead of standing still. The relative speed of the

(Continued on page 335)

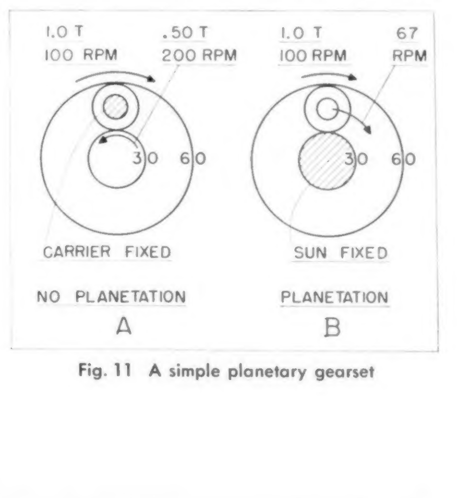


Fig. 11 A simple planetary gearset

Spray Deposits Measured Rapidly

L. A. Liljedahl and **John Strait**
Member ASAE *Member ASAE*

Fluorescent chemicals provide quick, accurate measurement of spray distribution in the field

RESEARCH and development work to improve the uniformity of distribution of sprays and dusts depends considerably upon the ability of the researcher to measure that distribution. Uniformity of spray application is important for two reasons. First, for almost all spray materials, a certain application rate has usually been established as the minimum amount that will do an effective job. When applied non-uniformly, a heavier than minimum amount must be applied in order to insure an effective job overall, resulting in a waste of spray materials. Second, many herbicides are selective in their action only within a certain, and sometimes quite narrow, range of application rates, there being a rate below which the weeds are not killed and another rate above which the crop is excessively damaged. In such cases it is plain that the herbicide must be applied uniformly if it is to be selective. Interest in spray distribution has been directed mainly toward large-scale uniformity of the spray deposit across the swath of the sprayer, since with systemic materials it is only necessary that each plant receive the same amount of spray.

Much laboratory testing of sprayers has been done by workers using equipment similar to that described by Riley (1)* or by Barger *et al* (2). In Riley's equipment the nozzle sprayed dye solution at a sheet of paper through a slot in a moving curtain. Barger *et al* used a corrugated device to divide the spray into narrow bands, and measured the amount intercepted in each band.

Unfortunately laboratory tests do not necessarily indicate with any reliability the distribution of spray material that may occur in the field because of the influence of such factors as ground roughness, wind, and, in the case of aircraft sprayers, the characteristics of the airplane. Generally there is not sufficient volume of spray material used to enable one to use the device described by Barger *et al* in field tests.

In order to test the performance of sprayers in the field, a number of other techniques have been used. These techniques include direct titration (3), measurement of dye solutions using photoelectric colorimetry (4, 5), direct weighing of the deposit (6), visual estimates from deposits on cards (7), and bio-assay (8). The presence of spray drifts has been detected through the use of fluorescent chemicals (9, 10, 11). These methods generally are either tedious or not particularly accurate.

The authors were engaged in a study of broadcast sprayer nozzles and it was felt that a procedure which would more quickly provide an accurate measurement of spray distribution in the field would be very useful. It would not only be useful for the present study of broadcast ground sprayers, but for workers studying the distribution pattern of any type of sprayer.

The method discussed in this paper was suggested by work of Brown and Marsh (14), who reported construction and use of a device in which a paper chromatogram, used to separate riboflavin, was exposed to ultraviolet light and slowly scanned longitudinally with a sensitive photometer. In this manner, electronic recording equipment indicated the relative distribution of riboflavin along the chromatogram.

Description of Investigations

The procedure developed and tested in this study is as follows: Spray containing fluorescent material is collected on a paper strip. The paper is passed under a scanning chamber which illuminates it with ultraviolet light and measures the fluorescence with a photocell. The photocell current is amplified and recorded on a strip-chart recorder. The recorder trace graphically indicates the distribution of

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The authors — L. A. LILJEDAHL and JOHN STRAIT — are, respectively, agricultural engineer (AERD, ARS), U.S. Department of Agriculture, and associate professor of agricultural engineering, University of Minnesota.

*Numbers in parentheses refer to the appended references.

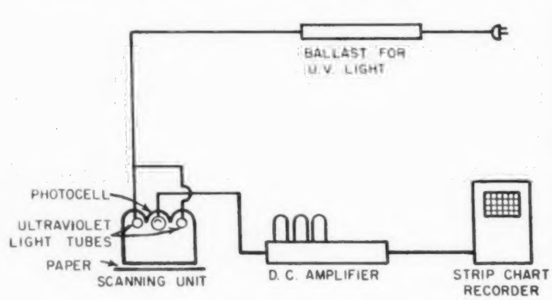

Fig. 1 Schematic diagram of the measurement technique tested. The strip of paper, which has collected a sample of the spray deposit across the swath of the sprayer, is drawn under the scanning unit and the fluorescence is recorded

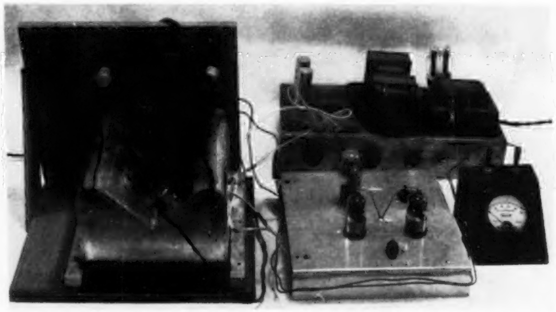

Fig. 2 Experimental equipment arranged for tests. At the left is the scanning chamber shown with the photocell enclosure in place on top. In the right foreground is the amplifier and meter, respectively, and in the background is the power supply

spray as collected on the paper. This arrangement is shown schematically in Fig. 1.

Equipment

The scanning chamber is visible in Fig. 2. The bottom of the chamber is open to the surface of the paper being scanned. The chamber, silvered on the interior, encloses two 6-watt BLB-type fluorescent tubes, which comprise the ultraviolet source. The photocell used was the type 929 and is exposed to the paper through an opening in the top of the chamber. It is enclosed in a small light-tight housing which is coated on the interior with black flocking to prevent reflections. Since the photocell is sensitive to ultraviolet light and a certain amount will be reflected from the surface of the paper, a filter to pass only visible light is placed in front of the photocell. The filter used initially was a Wratten No. 2B, which is essentially opaque below 400 millimicrons wavelength (19).

The amplifier, shown in Fig. 3, was constructed of a circuit design which appeared to be satisfactory for the type of measurements to be made in these investigations. The scanner amplifier system was first checked to verify that the amplification was not affected by supply voltage variations, and that the relationship between light flux input at the photocell and amplifier output was linear in the range being used.

A paper drive unit was constructed to be used with the scanner. The drive unit, shown in Fig. 4, consists of take-off and take-up spools and a friction drive roller driven by a small electric motor.

Laboratory Tests

Because the cellulose of which paper is made fluoresces slightly (16), and the chemicals added to paper in its manufacture are often fluorescent, it was necessary to test a number of papers to determine which types are suitable for collecting fluorescent spray deposits. Filter, school bond, drug bond, and bleached kraft papers were found to be satisfactory.

It first appeared that the light-colored papers fluoresced considerably, but it was soon found to be a reflection of a small amount of visible light, primarily violet, which the ultraviolet light tubes emitted. Changing the filter in front of the photocell from a Wratten No. 2B to a Wratten No. 9 (essentially completely opaque below 450 millimicrons wavelength) corrected this problem.

Screening of Fluorescent Chemicals

Samples of chemicals were obtained from companies which felt they might have materials suitable for this purpose. Solutions of each chemical were prepared (from 0.5 to 2 percent, depending on the suggestions of the manufacturers), sprayed on 8½ x 11-in. sheets of paper in an amount corresponding to approximately 10 gal per acre, and the fluorescence of each deposit was measured. It was found that nearly all chemicals were fluorescent when wet, but all except two lost virtually all of their fluorescence when dry. One of these was beta methyl umbelliferone (B.M.U.), also chemically known as 4-methyl-7-hydroxycoumarin, which is known to exhibit particularly bright fluorescence in the presence of cellulose. The other was a proprietary chemical, manufactured by Nova Chemical Company, called Lumogen L Light Yellow. This material is insoluble in water and was used as a suspension.

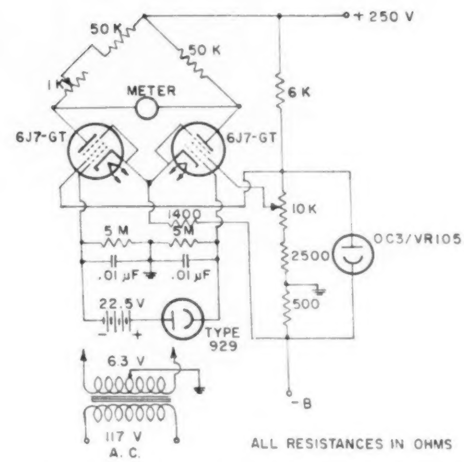

Fig. 3 Amplifier used in experiments. The bridge arrangement makes the zero setting practically independent of supply voltage variations. In addition, the use of a voltage-regulated screen supply makes the sensitivity of the circuit scarcely affected by supply-voltage variations

In preliminary tests, a spray containing 0.5 percent B.M.U. and 5 percent Na_2CO_3 was applied in varying amounts to 8½ x 11-in. sheets of bond paper. The relationship between the nominal amount of spray applied and the average fluorescence measurement was found to be nearly linear, but was not consistent among replications. A similar test was performed using a spray containing 0.5 percent Lumogen with 5 percent Novapol AC, a suspending agent. The results indicated that Lumogen would provide a consistent and linear relationship between deposit and fluorescence.

Linearity of Fluorescence

To more accurately establish the relationship between the amount of spray deposit actually present and its fluorescence, 8½ x 11-in. sheets of filter paper were sprayed with varying amounts of a liquid containing 0.5 percent Lumogen, 5 percent Novapol suspension agent, and 10 percent oxalic acid, and the fluorescence of each sheet measured. Each sheet was cut into small sections and placed in a 100-ml (milliliter) beaker containing 50 ml of water, and allowed to soak for 24 hr to dissolve the acid. Twenty-five milliliters of the wash water were then drawn off and titrated with 0.0343 N. NaOH. Bromthymol blue was used as the indi-

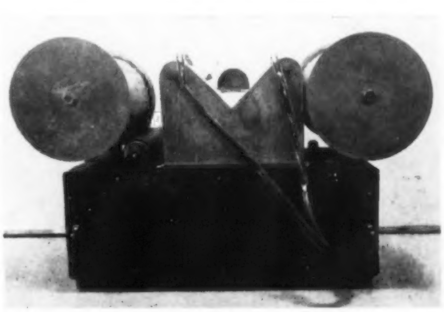

Fig. 4 Paper-drive unit for field use of this measurement technique. Width of paper strip used in tests described was 10½ in.

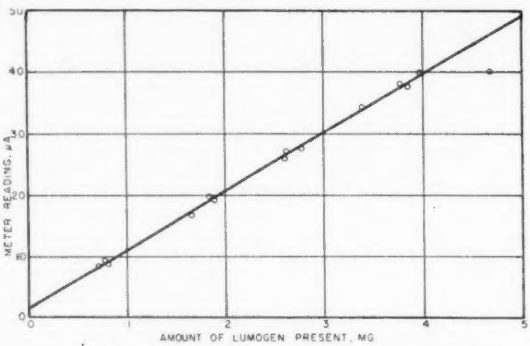

Fig. 5 Relationship of amount of chemical present and fluorescence measurement

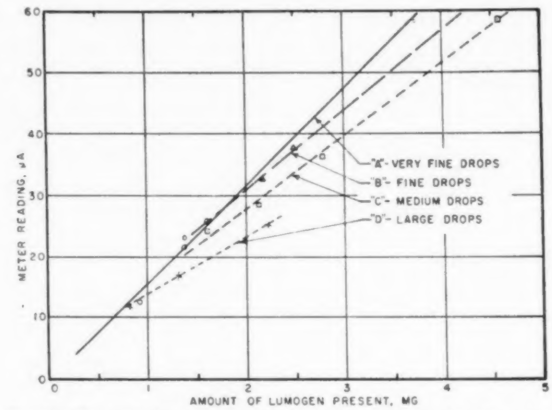

Fig. 6 Effect of droplet size on fluorescence. Droplet diameters in microns are approximately: very fine, under 250; fine, 250-500; medium, 500-1000; large, 2500

. . . Spray Deposits Measured

cator, with solution breaking sharply from yellow to green in the presence of the yellow suspension of Lumogen. The results of these tests are shown in Fig. 5. Obviously the relationship between fluorescence and amount of spray deposit is quite linear, although there is a small amount of variation.

Effect of Droplet Size

Since there was a small amount of variation from linearity, there was the possibility the fluorescence of spray deposits was affected by the size of the spray droplets which formed the deposit. A simple test was performed to study this possibility. Sheets of filter paper were arrayed in three rows at different distances from a nozzle projecting a heterogeneous spray horizontally so that the largest drops carried to row C and the smallest fell on row A. Another set of similar sheets, set "D", received larger drops directly from a pipette. The fluorescence and chemical deposit was measured as described previously under the final linearity tests. The results of these tests, shown in Fig. 5, indicate that the fluorescence of the deposit of a large droplet is less than if the same amount of fluorescent material were deposited in a number of smaller drops. This can be readily understood when it is considered that, as a large drop containing suspended fluorescent material falls on paper, the liquid in which it is suspended immediately begins to soak into the paper, leaving the suspended material filtered out on the surface. The larger the droplet, the thicker will be the film of the suspended material on the surface. Since the fluorescent material will be partially opaque, the ultraviolet light falling on the surface of the deposit will not reach the material at the bottom of the film with full intensity and the light emitted at the bottom will not be as great per unit of material as that at the surface. Furthermore, not all of the light emitted by the fluorescent material at the bottom of the film will reach the surface of the film, and thus the thicker the film of the fluorescent material, the less will be its fluorescence per unit of material. It follows that we should expect the fluorescence of deposits of large droplet sprays to be somewhat less than the fluorescence of finer droplet sprays.

If the slope of the curve in Fig. 4 is compared with curve D in Fig. 6, it can be noted that they are nearly the same (9.5 and 9.3, respectively). This is what we would expect from our knowledge of the general distribution of spray droplet sizes. In general, a spray from any given source will contain droplets of many sizes, with the percentage of droplets of each size normally distributed with respect to the logarithm of the droplet size. Because the volume of liquid carried by a droplet varies as the cube of the droplet diameter, most of the volume of spray liquid is deposited by a small number of larger droplets.

Field Test

The equipment was used to measure the distribution of a broadcast nozzle in the field using a mixture of 0.5 percent Lumogen, 5 percent Novapol, and 10 percent oxalic acid. The graph of the spray distribution given by the recorder is shown at the bottom of Fig. 7. At the top of Fig. 7 is a bar graph of the distribution measured by titration of wash water from successive 6-in. sections of the paper. Because the scanner has a smoothing effect, a curve indicating a running average of adjoining titrations has been drawn through the bar graph. The correlation between this running average curve and the top curve appears to be quite close. Fig. 8 shows the ordinates of the two curves at 6-in. intervals plotted against each other. The solid line is the best-fitting straight line; the broken lines show the 95 percent confidence interval for slope of the line, which is approximately ± 10 percent. Because the droplet sizes increase as the distance from the center increases with this type of sprayer, these data were divided according to dis-

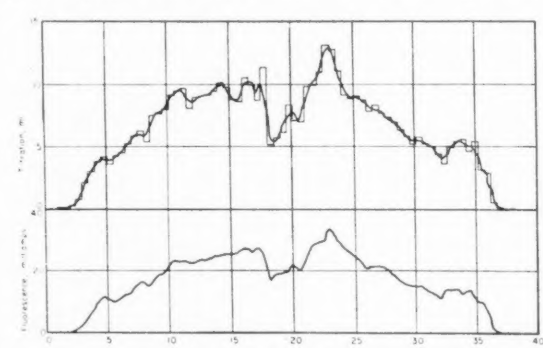

Fig. 7 Comparison of distribution patterns of a broadcast sprayer obtained by titration (upper graph) and by fluorescence measurement (lower graph). Heavy line in the upper graph is a running average of adjacent titration measurements

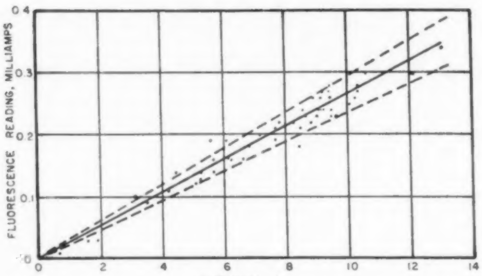

Fig. 8 Correlation of fluorescence measurements and titration measurements from Fig. 7. Broken lines indicate the 95 percent confidence levels of the slope of the best-fitting straight line

tance from the center line into five groups, and each group plotted separately to see if the scatter in this curve is due to variation in droplet size, but no such effect could be observed. It can be concluded from this limited examination of field use that the major inaccuracies in the use of this method are not due to the effect of droplet size.

It is perhaps significant that the chemical found best suited for this test procedure was the only one among those tried which was used as a suspension rather than a solution. Since this study did not attempt to screen all fluorescent chemicals for possible use in this procedure, there may be other chemicals more useful than the one used.

Summary

1 The measurement of the fluorescence of spray deposited across the swath of a sprayer is a good indication of the actual distribution of the spray. The procedure will be useful for the study of spray distribution from all types of sprayers, particularly broadcast and aircraft sprayers. By using two chemicals which fluoresce at different wavelengths and using proper filters, it should be possible to extend this procedure to "double boom" experiments.

2 It has been shown that the fluorescence of the deposit of paper of a spray containing a suspension of a fluorescent material is linearly proportional to the amount of spray material deposited, with maximum inaccuracies under adverse test conditions probably of the order of 10 percent.

3 The fluorescence of the spray deposit is affected by the droplet size within the spray, deposits of large droplets being somewhat less fluorescent than those of smaller droplets. However, the effect of this in a field test of a sprayer could not be detected.

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. . . Evolution in Transmissions

(Continued from page 331)

ring and carrier is now 100 − 67 = 33 rpm. This is the tooth engagement speed in revolutions per minute. The horsepower at the ring gear mesh is therefore 1 × 33 = 33 percent of input horsepower. The losses at the tooth meshes of *B* are therefore approximately one-third of those at *A*. This assumes that other factors affecting efficiency are the same at *A* and *B*, but there might be a slight variation in the coefficient of friction at the different speeds.

Thus the tooth loss at all the working meshes of any two transmissions can be compared, keeping in mind that the sums of the horsepowers in percent of input horsepower are in the same proportion.

It is not necessary to calculate the horsepower in percent of input at both the sun gear and ring gear. Although the speed and torque is different at each, torque times relative speed is always the same for each. For convenience, only one planet per gearset is assumed, as this is simpler and makes no difference in the calculations.

In a planetary transmission having two or more planetary sets compounded, the two sets can be calculated as in Fig. 11. With two or more planetary sets coupled in differential relationship, the sun, ring and planet carrier of one set all rotate at different speeds. This requires tracing the torque paths in order to determine the torque and relative speeds for each set.

In combinations having a parallel torque path, one planetary may have its carrier held stationary, as in Fig. 9, and still have low tooth losses because only a fraction of the torque is passing through this one set in the particular gear ratio being considered.

A countershaft transmission usually has two or three working meshes in forward speeds. Since there is no planetation, the sum of the horsepowers at these meshes is 200 percent of input power for two meshes. The losses at the teeth alone as indicated by this figure are about the same as in a planetary with four working meshes. This would be the case in a speed in which two simple planetaries were both working. In general these tooth losses per mesh figure out on an average at about half of those in a countershaft unit.

In a planetary these tooth losses will be less in those speeds in which one or more gearsets are locked up in direct drive. In one of the top speeds all may be locked up, in which case there are neither tooth losses or gear-idling losses.

On the other hand, there are clutch-drag losses as described above. The drag of a clutch can be greatly reduced by locating it at a point in the power train where the relative speed of the plates is low, as has been done in the designs illustrated herein. The brake bands resting on their drums also cause a slight drag but this is very small.

The power required to operate the hydraulic pump represents the largest loss in a transmission. Much depends on the pump pressure and delivery volume required. This may cause the total overall losses to slightly exceed those of a countershaft transmission in some cases in spite of eight favorable factors described above.

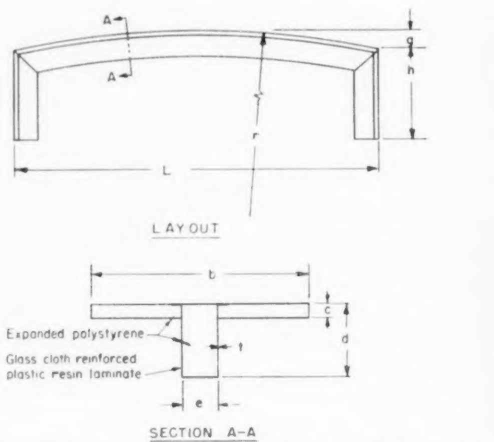

Fig. 1 Layout and cross section of experimental rigid frame of glass cloth reinforced plastic resin laminates and expanded polystyrene. See Table 1 for dimensions of prototype and models


Fig. 2 Model frames built of glass cloth reinforced polyester resin used in the study

Glass-Fiber Plastics in Farm Building Construction

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Member ASAE *Member ASAE*

Investigation of advantages of fibrous-glass reinforced plastics for developing construction methods to reduce on-the-site labor requirements

On account of the scarcity of labor available for farm construction, it is important to develop building methods that will reduce on-the-site labor requirements. In addition, since most conventional building materials are susceptible to the effects of weather and use, so that maintenance becomes a problem. Fortunately new materials are being developed which can be adapted to farm construction.

The use of plastics in farm building construction has been generally limited to translucent glass-reinforced panels for lighting purposes and solid films as temporary surfacing materials for greenhouses, silos and temporary storage facilities for farm produce, machinery and miscellaneous uses.

Following are some of the advantages in using glass-reinforced plastics as a construction material: *(a)* They have high strength-weight ratios, *(b)* they are waterproof, *(c)* they will not decay, *(d)* they are heat-resistant, and *(e)* they can be molded into any shape with very little difficulty. The latter advantage permits prefabrication of building elements that can be easily assembled on the site.

The objectives of this experiment were *(a)* to develop a system of construction which when erected would include the complete wall section plus structural frame, and *(b)* to apply a type of fiber reinforced plastic to a structural building unit.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1958, on a program arranged by the Farm Structures Division, and approved as journal article 2351 of the Michigan Agricultural Experiment Station.

The authors—Robert A. Aldrich and James S. Boyd—are, respectively, associate professor and professor of agricultural engineering, Michigan State University.

Preliminary Investigations

Plastics are defined as "a large and varied group of materials which consist of, or contain as an essential ingredient, an organic substance of large molecular weight which, while solid in the finished state, at some stage in its manufacture is made liquid and thus capable of being formed into various shapes, most usually through the application, either singly or together, of heat and pressure(5)*. Laminates and reinforced plastics are those materials in which the plastic, usually in liquid form, is used as a binder and surfacing material in conjunction with reinforcing materials such as glass mat, glass cloth, paper, etc.

Two commercially available resins, a modified epoxy and a polyester, were used in this study. Both resins start as mobile liquids and can be converted quickly to solids. They are 100 percent reactive, *i.e.*, no gas or liquid is evolved during the curing process(7, 8).

Glass fibers make excellent plastic reinforcements because (1) they have strengths greater than steel, (2) there is no moisture absorption, (3) they develop high interface shear strengths with plastic resins, and (4) they are available in almost unlimited quantity. Fibrous-glass reinforcement is available in several different forms, such as glass mat, rovings, or glass cloth. Glass mat consists of random

*Numbers in parentheses refer to the appended references.

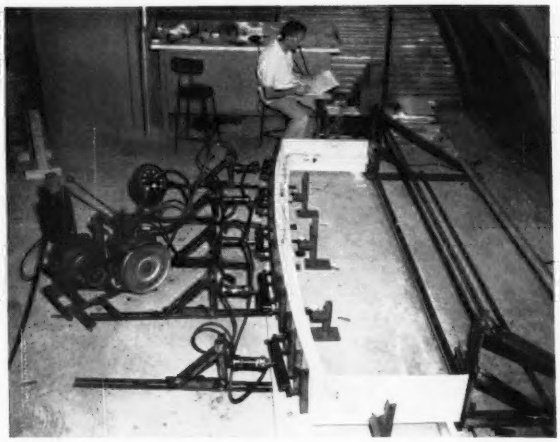

Fig. 3 Model E025050 under test in the structures laboratory

lengths of fibers with no particular orientation. Glass cloth has threads in two directions in the weave. Threads running parallel to the length of the cloth are known as "warp" threads. Those running across the length of the cloth and perpendicular to the warp are referred to as "pick" threads. Rovings are produced essentially by winding a number of ends of sliver onto a core. They are not twisted or plied, but sometimes a binder is used to hold them together (3). Plain weave cloth was used as reinforcing for the structural elements molded for the investigation.

The Investigation

A rigid frame of 40-ft span was designed (Fig. 1) which would *(a)* provide clear span, *(b)* permit prefabrication, *(c)* provide skin and frame as an integral unit, and *(d)* allow convenient building expansion.

The frame was analyzed using the method of "virtual work" with the horizontal reaction component at the right support chosen as the redundant. The maximum moment occurs at the junction of the beam and column, 112w lb-ft, where w is the intensity of the vertical load in pounds per foot of horizontal projection of the beam.

Experimental evidence was necessary in order to adequately test a structural design involving a new material. To reduce the cost for construction materials and test equipment, a model analysis was completed for the frame and the hypotheses tested using distorted models.

Model Analysis

A model is a device which is so related to a physical system that observations on the model may be used to predict the future performance of the physical system in a given respect (4).

The first step in any model analysis is to develop prediction equations for the desired phenomena. For structural models, stress and deflection best describe the action of a structural member under load. Accurate prediction equations can be developed if the principles of model theory and similitude are employed correctly. Use is made of the Buckingham pi theorem in developing the prediction equations.

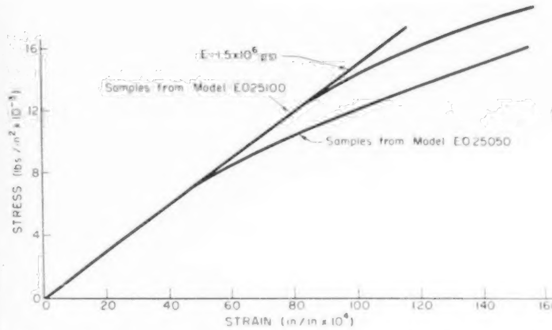

Fig. 4 Average stress-strain curves in tension parallel to the warp for epoxy resin-glass cloth laminate

The variables to be considered and their respective dimensions are:

Variables	Dimensions
s = stress	$F\text{-}L^{-2}$
L = length of span	L
λ = any length (layout)	L
η = any length (cross section)	L
w = load per foot of beam	$F\text{-}L^{-1}$
E = modulus of elasticity	$F\text{-}L^{-2}$

$$s = f(L, \lambda, \eta, w, E)$$

There are 6 variables and 2 fundamental quantities; therefore, there will be 6—2=4 pi terms.

$$\pi_1 = sL/w, \quad \pi_2 = \lambda/L, \quad \pi_3 = \eta/L, \quad \pi_4 = w/EL$$

or

$$\pi_1 = f(\pi_2, \pi_3, \pi_4)$$

The same terms apply to the model.

$$\pi_{1m} = s_m L_m/w_m, \quad \pi_{2m} = \lambda_m/L_m, \quad \pi_{3m} = \eta_m/L_m, \quad \pi_{4m} = w_m/E_m L_m$$

and

$$\pi_{1m} = f(\pi_{2m}, \pi_{3m}, \pi_{4m})$$

The design conditions become:

$$\lambda/L = \lambda_m/L_m, \quad \eta/L = \eta_m/L_m$$

the operating conditions are

$$w/EL = w_m/E_m L_m$$

and the prediction equation for stress is

$$sL/w = s_m L_m/w_m$$

A similar procedure is used for developing a prediction equation for deflection. The final equations being for the operating conditions:

$$w/EL = w_m/E_m L_m$$

for the design conditions:

$$\lambda/L = \lambda_m/L_m, \quad \eta/L = \eta_m/L_m$$

and the prediction equation for deflection is

$$d/L = d_m/L_m$$

. . . Glass-Fiber Plastics

A layout scale of four was chosen for a model of a 40-ft span frame, *i.e.*, the frame layout dimensions are four times the model dimensions. This scale was satisfactory for layout, but if used for the cross section would result in a very thin skin which could cause difficulty both in construction and in behaviour under load. Therefore, distorted models were used, *i.e.*, the cross section scale differed from the layout scale. When a distorted model is used, there has to be two models, one being essentially a distorted model of the other. This is necessary in order to prove the original model. If the prediction equations for the distorted models are proven correct, then the information secured from the tests can be applied with confidence to the full-scale structure.

From Murphy(4), the prediction factors considering bending-type loads are, for displacement, α^4, for stress, α^3 where α is defined as $\alpha^4 = I_m n^4/I$, n is the length scale, I is the moment of inertia of the cross section.

Therefore, the prediction equations become

$$\frac{sL/w}{s_m L_m/w_m} = \alpha^3, \quad \frac{d/L}{d_m/L_m} = \alpha^4$$

Referring to the operating conditions, if the same material is used in model and prototype, then

$$w/w_m = EL/E_m L_m = n$$

Thus the prediction equations for stress and deflection become:

$$s = \alpha^3 s_m$$

$$d = n\alpha^4 d_m$$

The model frames were analyzed in the same manner as the full-scale frame. The stress at midspan: $s = -52.8\ wc/I$ lb/in²; the deflection at midspan, $d = (0.12 \times 10^6)\ w/EI$.

The relationship between the models built with a given resin are given in Table 2 using moments of inertia given in Table 1. The two frames using polyester resin are shown in Fig. 2. In the discussion that follows, the frame with the larger cross-section dimensions is considered the model, the other the prototype.

TABLE 1. LAYOUT AND CROSS SECTION DIMENSIONS OF THE FRAME AND MODELS

Structure	Dimension								
	l (ft)	g (ft)	h (ft)	r (ft)	b (in.)	c (in.)	e (in.)	I (in.)	C (in.)
Frame	40	2	10	10	24	8	4	40	6.2
Model:									
E025050[1]	10	0.5	2.5	25	12	4.38	2	3.03	3.38
E025100	10	0.5	2.5	25	24	8	4	35.90	5.55
P025050	10	0.5	2.5	25	12	3.75	2.13	4.13	2.82
P025100	10	0.5	2.5	25	24	7.70	4.19	44.29	5.66

[1]The model frame designation *E* indicates epoxy resin, the first three digits indicate layout scale (e.g., 025=one-quarter scale), the last three digits indicate cross-section scale (e.g., 050=one-half scale).

TABLE. 2. MODEL RELATIONSHIPS FOR THE DISTORTED MODELS

Epoxy Resin	*Polyester Resin*
$n = 1$	$n = 1$
$\alpha = 1.86$	$\alpha = 1.81$
$s = 6.47\ s_m$	$s = 5.96\ s_m$
$d = 11.83\ d_m$	$d = 10.8\ d_m$

Test Facilities. A special test floor was built so that the frames could be loaded in a horizontal plane through a sysstem of hydraulic cylinders and loading shoes. Fig. 3 shows frame E025050 under test. The reaction braces are so constructed that there was negligible displacement during the loading tests. The whiffletree arrangement of the loading shoes allows loading perpendicular to the span. The individual loading shoes are 6 in. on center which would be equivalent to 2 ft on center loading on the full-scale frame.

Model Construction. The frames were constructed using a no-pressure hand-wet layup process. Wood female molds were built in which the flange sections were formed. Resin manufacturers' directions were followed as closely as possible in the preparation of the molds and in laminating. Mold preparation consisted of *(a)* cleaning the surface, *(b)* applying a layer of paste wax, *(c)* applying a layer of parting agent (a proprietary liquid mix), and *(d)* applying a final layer of paste wax. Careful preparation permits the cured laminate to be easily stripped from the mold.

The laminating process consists of the following steps: *(a)* apply a brush coat of resin to the mold, *(b)* place a layer of glass cloth in the mold and work out all the air bubbles with a flat paddle (which also assures adequate wetting), *(c)* apply another layer of resin, *(d)* place another layer of glass cloth, and *(e)* apply another layer of resin. Continue the process until the desired number of laminations are obtained. In this investigation a total thickness of ⅛ in. was used. As recommended by the resin manufacturers, an attempt was made to produce a laminate approximately 50 percent resin and 50 percent cloth by volume. The resin reaches its peak exotherm a few minutes before beginning to gel. At this time it has the consistency of water so there is danger of resin starving if the laminating process is carried on too rapidly. The resin cures to a hard mass in approximately 3½ hours at 70 F and reaches full strength in about 12 hours. Precautions must be observed in handling epoxy resin as resin contact with the skin causes irritation and mild dermatitis. Polyester resin is generally nontoxic to the skin.

The beam and column sections were laid up separately and joined, after curing, by laying resin-glass cloth scabs along the stem and over the outside of the flange with a gusset plate set in the joint to allow the entire width of the flange to carry load around the corner into the column.

Instrumentation. Type A-1, SR-4 electric resistance strain gages were bonded to the outside of the stem and flange at the crown to provide stress information. Dial indicators were used to measure deflection.

Material Constants. To check both the quality of laminate produced and the design predictions, it was necessary to determine the material constants for each resin laminate

TABLE 3. MECHANICAL PROPERTIES OF TWO PLASTIC RESINS REINFORCED WITH GLASS CLOTH

	Resins				
	Epoxy			Polyester	
Mechanical Property	*A*[1]	*B*[2]	*C*[3]	*A*[1]	*B*[2]
Max. strength, flexure (10^3 x psi)	45-80	20.8	28.0	50-63	23.3
Max. strength, tension (10^3 x psi)	33-50	21.9	27.4	40-50	17.3
E in flexure (10^6 x psi)	2.0-3.6	2.4		2.0-3.0	2.3
E in tension (10^6 x psi)	2.4-3.5	1.5		1.0-2.8	1.6

[1]Data from Modern Plastics Encyclopedia Issue XXXIII (September 1955) p. 868.
[2]Data from tests on samples cut from model frame flange laminates.
[3]Data from resin manufacturer.

used in the models. Moduli of elasticity and maximum strength in tension and bending were determined from samples cut from the flange laminate of each frame. The test samples were prepared and tested according to ASTM designations(2). The results of these tests are shown in Table 3. A typical tension stress-strain curve is shown in Fig. 4.

Frame Testing. The frames were tested by applying short-term static loads as indicated in Fig. 3, with the loads applied in increments until the desired level was reached. Strains sensed by the SR-4 gages were measured by a Young strain indicator. Deflections at the crown were measured by a dial indicator. Additional dial indicators were used to detect lateral movement of the frame during testing. Long-term loading tests were made with Models E025050 and P025050 to evaluate creep characteristics of the material.

Results and Discussion

Use of Construction Materials. Successful use of no-pressure, hand-wet layup laminating with the two resins is possible although some experience is helpful to insure a uniform product. Care must be exercised to prevent air inclusion during laminating. If laminate thickness is built up too rapidly, resin runout at peak exotherm will result in the upper cloth fibers being without sufficient resin to produce their maximum strengths. A too rapid resin buildup will also result in the cloth floating, causing uneven distribution of glass through the section.

Mechanical Properties of the Materials. The stress-strain curves in tension for the laminates are characteristic of a brittle material. The curved form of the curves is due to preferential failure in the specimens. Because of the twisting and bending of the glass filaments in the production of the cloth, it is not possible to equally load all filaments simultaneously, resulting in some being stressed to failure before others. This was audibly apparent during testing as the individual strands broke with a pronounced snap as the load increased.

The moduli of elasticity in tension and bending fall in the range of values given by other sources (9). The maximum strengths in bending and tension are low for the epoxy resin laminate due possibly to inexperience in working with the materials. Maximum stress in tension and bending is low for the polyester resin laminate; however, the values quoted from other sources are for a low-pressure laminate and not for zero-pressure molding as was the case in this investigation.

The moduli of elasticity in tension as determined were used to relate strain sensed by the SR-4 gages to stress in the outer fibers. Moduli of elasticity in bending were used in estimating deflection of the frames.

Model Analysis. If the proposed solution for the frame is to be valid, the test results should show reasonable agreement both from a model prototype comparison and from a comparison of tests results with the estimated values for the phenomena being measured. Table 4 shows the measured and estimated values for stress and deflection at the crown for the four frames. In all cases except one, the measured values are less than estimated. The one exception is P025050 in which the measured stress is approximately 9 percent above the estimated value. Although the differences in some instances appear to be rather high, the analysis can be considered valid. Ratios of estimated and measured values for stress and deflection for the two model pairs are shown in Table 5. The differences between measured and estimated values are all under 10 percent. Agreement within this range supports the decision that the analysis can be accepted and the results used in the design of a full scale structure.

Referring to the model analysis, the prediction equations for stress and deflection for a full-scale frame, based on the results for Model P025100 are $s=64s_m$; $d=1024d_m$. Therefore, if we want to use measured values to predict frame behavior, we find, for a design load of 60 lb per foot of beam (30 lb per sq ft of projected roof area), that the stress in the lower fibers at the crown will be: $s=64s_m=64(6.65w_m)=64(6.65)(15)=6400$ psi, and the deflection at the crown will be: $d=1024d_m=1024\times0.00105w_m=1024\times0.00105\times15=16.1$ in. From the original model analysis ($w=nw_m$), a 15-lb ft load on the model is equivalent to 60-lb ft load on the full-scale frame.

It is apparent that the frame design is rather flexible and probably should be altered to increase the stiffness. The point to be emphasized, however, is that the model analysis is valid and information from the problem can be used to support future design estimates.

Models P025050 and E025050 were loaded with constant uniformly distributed loads of approximately 40 percent of failure load until position equilibrium was reached. The frames were then unloaded and observations made at intervals to check the return to the unloaded position. There was no evidence of creep nor any permanent set apparent in either frame.

Conclusions

1 Epoxy and polyester resins reinforced with glass fibers produce a laminate uniform in mechanical properties suitable for use as a structural material. In addition to their advantages such as rot resistance, water-proofness, strength, etc., the reinforced plastics can be easily molded into an infinite number of shapes.

2 The use of structural models permits investigation of hypotheses concerning mechanical phenomena in structures

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TABLE 4. ESTIMATED AND MEASURED VALUES OF DEFLECTION *(d)* AND LOWER FIBER STRESS *(s)* AT THE CROWN OF THE FOUR MODEL FRAMES

Resin	Epoxy				Polyester			
Model	E025100		E025050		P025100		P025050	
	d (in.)	s (lb/in.²)	d (in.)	s (lb/in.²)	d (in.)	s (lb/in.²)	d (in.)	s (lb/in.²)
Estimated	0.00139w	8.08w	0.0165w	59.0w	0.00118w	6.75w	0.0126w	36.1w
Measured	0.00126w	6.75w	0.0139w	51.8w	0.00105w	6.65w	0.0104w	39.4w
Percent diff.	9.3	16.4	15.8	12.2	11.0	1.5	17.5	9.1

TABLE 5. Estimated and Measured Values of Deflection and Stress for the Model and Prototype* for Two Resin-Gloss Cloth Laminates

Resin	Epoxy		Polyester	
Ratio	d/dm	s/s_m	d/d_m	s/s_m
Estimated	11.83	7.3	10.8	5.35
Measured	11.03	7.63	9.9	5.84
Percent diff.	6.8	5.1	8.3	9.1

*Prototypes are E025050, P025050; Models are E025100, P025100.

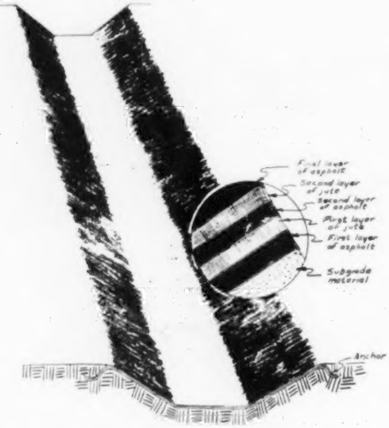

Fig. 1. Asphalt-burlap laminate canal lining

Asphalt-Burlap Linings for Canals and Reservoirs

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Affiliate ASAE

Results from a test installation of a built-up asphalt-burlap laminate structure for canal and reservoir linings

ASPHALT, because of its waterproofing and adhesive properties, would seem to be adapted for the construction of canal and reservoir linings. Where used as a mastic or mortar for bonding brick and tile, it proved effective, but as exposed linings in the form of membranes or cold asphaltic concrete mixes, the linings have not lasted well. Hot mix asphaltic concrete linings have given better service, but are costly. Buried membrane linings, where properly constructed and maintained, have also given good service. Buried linings are objectionable, however, for several reasons, and asphalt membranes were buried as a last resort in the search for better durability.

The addition of fillers to asphalt, whether organic or mineral, adds greatly to the life of the asphalt when exposed. Mineral fillers have been used with good results. However, the incorporation of mineral fillers and the spreading of the mix present construction problems, and the few test linings constructed have not been entirely satisfactory. Fillers in substantial amounts are used in the ½ inch or thicker, prefabricated asphaltic liners and the better durability of these liners can probably be attributed to the use of fillers and the protective action of the felt facings used on these liners.

Some years ago, a built-up asphaltic lining using a cotton fabric was constructed in the vicinity of Grace, Idaho*. This lining controlled seepage for a time but was not considered satisfactory. The cotton fabric deteriorated—probably because it was untreated—and after a few years considerable difficulty was experienced with breaks resulting from piping of the subgrade material. The lining was constructed in an area where fractured basalt was only a few feet from the surface in places. The site, therefore, doubtless was a contributing factor to the rapid failure and would present construction and maintenance problems regardless of the type of lining employed. Recently the use of a laminated asphalt-burlap type of ground cover for surfacing air fields in India came to our attention. Samples of the structure were examined and were found to be somewhat brittle, but otherwise in reasonably good condition after twelve years of service. Encouraged by the apparent durability of the asphalt-burlap structure, consideration was given to the use of a similar structure for canal and reservoir linings and a test installation was made in August 1955.

*Canal lined with cotton fabric (*Engineering News-Record* 122:852-853, 1939).

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The authors—C. W. LAURITZEN and FRANK W. HAWS—are, respectively, soil scientist, western soil and water management branch (SWCRD, ARS), U.S. Department of Agriculture, and research assistant in irrigation engineering, Utah Agricultural Experiment Station.

Test Linings

The asphalt used in this lining was a 50-60 penetration catalytically blown asphalt with a softening point of 190 F. Approximately one gallon of this asphalt was sprayed directly on the subgrade at a temperature of about 400 F. Immediately after the asphalt was sprayed, a layer of 10-oz mildewproof burlap was spread on top of the asphalt. Care was taken to remove any wrinkles. Another layer of asphalt was sprayed on the burlap at the rate of ¾ gal per square yard. This second layer of asphalt in turn was covered with another layer of burlap and the burlap sprayed with ¼ gal of asphalt to bond it to the surface.

In October, 1955, a similar lining was installed in a 33-ft section of field ditch in the vicinity of Tremonton, Utah. The ditch was trapezoidal with an 18-in. bottom and 1:1 side slopes and an overall depth of about 2 ft. Another section of ditch about the same size and 100 ft long was lined in the vicinity of Farson, Wyo., in September 1956. About half of this lining was single-ply and one-half two-ply. Lining was started on a 682-ft section of another ditch in Tremonton, Utah, November 29, 1956. The lining of this ditch was interrupted by the winter weather with only 350 ft of lining completed. The remainder of the lining was installed in April 1957. All the above installations, it will be noted, are located in moderately cold climatic regions. Although the performance of these linings was promising, there was some question about how linings of this type would perform in warmer regions. In order to learn something of the influence which hot weather would have on this lining, arrangements were made to install a short section of the lining on the Wellton Mohawk development farm in the vicinity of Yuma, Ariz. This installation



Fig. 2 *(Left)* Ditch trimmed and ready to be lined with built-up asphalt lining • Fig. 3 *(Center)* Applying first coat of hot asphalt to built-up asphalt ditch lining • Fig. 4 *(Right)* Applying first layer of jute burlap to built-up asphalt ditch lining

was made in February 1957. The ditch was trapezoidal in shape and had a lined perimeter of about 9 ft.

Performance of Linings

All the test linings are in good condition and appear to be controlling seepage satisfactorily. Although seepage measurements have not been made on all of the test installations, those on which measurements were made showed very small losses. For example, the loss in cubic feet per square feet per day for the test lining at Farson, Wyo., was less than 0.26. This measurement represents the combined loss on both the two-ply and single-ply portions of this lining. The measured loss from the unlined ditch was 2.7. Again the seepage loss from a test section and a test reservoir at our outdoor laboratory at Logan showed an average loss of 0.04 and 0.005, respectively, for the 1957 irrigation season. Seepage losses from the Arizona test lining likewise were small, being 0.04, based on a measurement made on October 15, 1957.

Procedure for Construction

The subgrade for the built-up asphalt lining should be firm and fine-textured. Where coarse-textured material, such as gravel and shale, is encountered in the invert, the surface should be covered with a fine-textured material. Any earth material as fine or finer than sand will be satisfactory. Care should be taken to compact the surface material. This can be done by settling with water or rolling.

In connection with the excavation and trimming of the invert, a trench should be constructed on the berm on both sides of the channel and the surface prepared in the same manner as the subgrade of the canal invert. The trench is employed as a means of anchoring the lining. It should be 6 to 12 in. deep and located parallel and 6 to 12 in. from the top edge of the canal or reservoir. Care should be taken to spray the asphalt in a continuous layer over the invert, including the invert of the trench. The burlap likewise is continued over the berm and looped into the trench. After the construction of the lining is completed, the trench is backfilled and the backfill compacted to anchor the lining along the top edge, Fig. 1. If this installation procedure is followed, the lining will not sag on the side slopes, even when used in a canal semicircular in shape. Side slopes greater than those at which the invert material is stable should not be used, however, since the lining affords little support to the subgrade material. Unless the structure to be lined is located in sterile material, the subgrade should be treated with a soil sterilant to prevent vegetative growth from developing and puncturing the lining.

Successive stages in the construction of this lining are shown in Figs. 2, 3, 4, 5, and 6.

Fig. 5 *(Top)* Spreading second coat of hot asphalt to built-up asphalt ditch lining

Fig. 6 *(Bottom)* Completed ditch with built-up asphalt ditch lining

Materials

The asphalt used in these built-up linings is the catalytically-blown asphalt previously mentioned. This asphalt was selected because of its known properties of toughness and better durability. It is possible that other asphalts might be used satisfactorily, possibly higher-penetration asphalt cements with a high percentage of mineral filler.

Specimens of burlap and burlap-asphalt laminates cut from test-lining installations were buried in our compost tank to determine their resistance to biological decomposition. The results of this test and the composition and treatment of specimens are shown in Table 1.

The specimens of the asphalt-burlap laminate which were buried in the compost with exposed burlap edges showed some shrinkage and distortion after nine months, indicating that the burlap reinforcing had deteriorated to a degree. The samples with coated exposed edges showed little if any shrinkage or distortion after this nine-month period, Fig. 7.

TABLE 1. CONDITION OF BURLAP AND ASPHALT-COATED BURLAP SPECIMENS

Material	Treatment	Condition after burial*
Natural burlap as it comes from the mill	None	Serious deterioration after 1 month
Commercial treated burlap	"Impervitex"	Deteriorated after 4 months
Copper napthanate treated burlap	Lot A — U.S. Army spec.	Deteriorated after 9 months
Copper napthanate treated burlap	Lot B — 150% Army spec.	Deteriorated after 15 months
Copper napthanate treated burlap	Lot C — 200% Army spec.	Still intact — 21 months
Asphalt-burlap laminate Lot A burlap + C-190 asphalt	Exposed edges	Condition after 9 months is indicated in Fig. 7
Asphalt-burlap laminate Lot A burlap + C-190 asphalt	Sealed edges	

*Condition is based on visual observation only. Further tests are being conducted using tensile strength as a basis of comparison.

The fact that untreated burlap is too badly decomposed to handle after one month in the compost and has almost entirely disintegrated after two months indicates a much higher rate of deterioration than is associated with normal outdoor exposure in contact with the soil, but it is not possible to project accurately the service life from compost measurements. If we assume one year in the compost equals about seven years under natural outdoor soil conditions, the burlap laminate with exposed edges would have an expected life of about twelve years.

Costs

Most of the test installations were made using packaged asphalt which had to be shipped and reheated in a small distributor. Because of this, the costs were high and in no way comparable to a commercial job. The test installation in Arizona was the exception. On this job, hot asphalt was supplied and spread by a contractor. The asphalt was transported in an insulated tank truck supplied with heaters to insure delivery at the destination in liquid form and provide for heating to temperatures required for application. The cost of the asphalt was 13 cents per gallon f.o.b., Compton, Calif. Freight to Yuma amounted to 5 cents and spreading cost 6 cents. It is estimated that the treated burlap would cost 22 cents per square yard and laying would cost another 2 cents. The projected costs per square yard are given in Table 2.

TABLE 2. COST OF DITCH LINING PER SQUARE YARD

	Application rate, gallons per square yard	
	2.0 (two-ply)	1.5 (one-ply)
Asphalt, in place (24¢ per gallon)	$0.48	$0.36
Burlap, in place (24¢ per square yard)	.48	.24
Total	$0.96	$0.60

Summary

There is a real and ever-increasing need for lower cost canal and reservoir linings. A lining which is low in cost in one area, however, may be high in cost in another, depending upon site conditions and the availability of materials. It is doubtful if any one type of lining will ever be developed which will be superior under all conditions.

Asphalt is one material which offers attractive possibilities for lining construction. The investigations of asphalt as a lining material, however, have indicated some serious limitations. One of these has been the rapid deterioration of exposed asphalt. To overcome this problem, a buried asphaltic membrane was developed by the U.S. Bureau of Reclamation. Buried membranes of all types have the disadvantage that the lined perimeter must be considerably greater to have the same capacity as a canal with an exposed lining. Repairs are also difficult to make and stream velocities must be restricted greatly. The search, therefore, was continued for a low-cost exposed membrane lining. The built-up lining described offers possibilities of at least partially meeting this need. It is not known just how long this lining will last, but where properly installed, it is expected to last for some time. A feature of this lining which makes

(Continued on page 344)

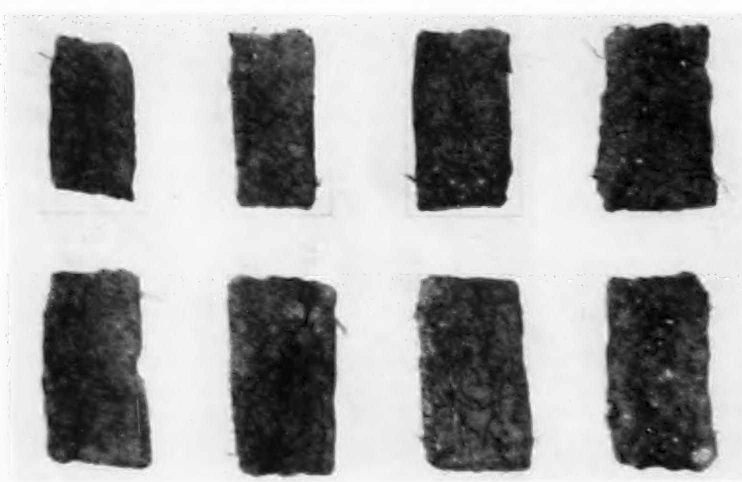

Fig. 7 Asphalt-burlap specimens after 15 months in a soil compost; with exposed edges (top); with edges sealed (bottom)

INSTRUMENT NEWS

Strain Gages Determine Pressure-Displacement Relationships

J. L. Butler and **H. F. McColly**
Member ASAE *Member ASAE*

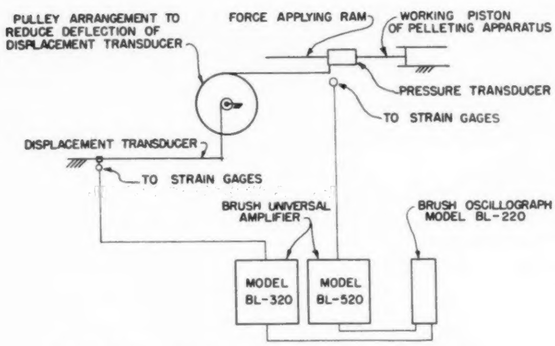

Fig. 1 Schematic diagram of pressure and displacement measuring system

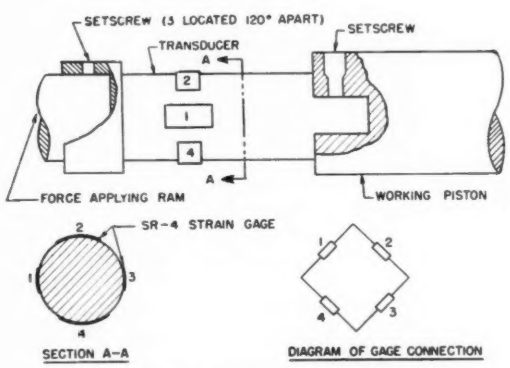

Fig. 2 Pressure transducer

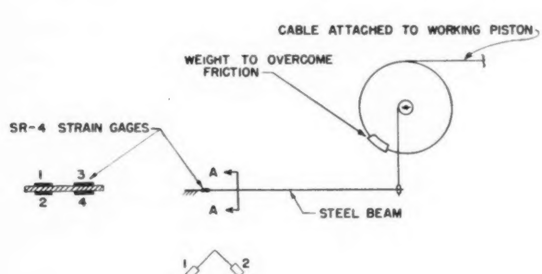

Fig. 3 Displacement transducer

IN HAY pelleting research, it was necessary to devise a system for measuring and recording pressure and displacement so that their relationship could be determined. The system shown in Fig. 1, utilizing electrical strain gages as sensing elements, was used. The recording oscillograph gave a permanent record of pressure and displacement as a function of time.

Fig. 2 shows the gage location and method of connection for the pressure (by method of calibration) transducer. Gages 1 and 3 are mounted diametrically opposite each other and have their axes parallel to the axis of the link. These are the primary sensing elements and would provide a satisfactory electrical output if it were not necessary to provide for temperature compensation. Gages 2 and 4 provide temperature compensation and are mounted with their axes perpendicular to the axis of the link. In addition to providing temperature compensation, these gages sense strains due to the Poisson effect and increase the output of the bridge. With the gage location and arrangement shown, any strains due to bending are automatically cancelled and the bridge will not be unbalanced as the result of loads other than pure compression (or tension).

The pressure transducer was calibrated in a Tinius Olsen Universal Testing Machine by loading up to 70,000 lb, in increments of 5,000 lb and then removing the load by the same increments. Four such cycles were made, the average strain for each interval was calculated and a force vs. strain curve was plotted so that the *K* value, or slope of this curve, for the transducer could be determined. This curve showed the transducer to be linear throughout the test range.

The *K* value was used in the calibration of the amplifier so that the recorder chart could be read directly in pounds per square inch. This was accomplished by multiplying the cross-sectional area of the working piston by 100 to get the force necessary to produce a pressure of 100 psi. Dividing the product by the *K* value gave the strain produced by this force. The gain of the amplifier was then adjusted so that

(Continued on page 344)

An Instrument News Contribution. Articles on agricultural applications of instruments and controls and related problems are invited by the ASAE Committee on Instrumentation and Controls, and should be submitted direct to Karl H. Norris, instrument news editor, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md. Paper is approved for publication as Journal Article No. 2386 of the Michigan Agricultural Experiment Station.

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. . . Strain Gage Uses

(Continued from page 343)

each division on the recorder chart was equivalent to this amount of strain; hence, each division on the chart could be read as 100 psi. Once the calibration was made, the value per chart division could be readily changed by changing the attenuator setting on the amplifier.

The displacement transducer is shown in Fig. 3. Since the working piston had a stroke of 16 in. the pulley arrangement shown was used so that a relatively short cantilever beam could be used without the stress exceeding the proportional limit. With the gage arrangement shown, only bending strains were indicated and the bridge was not unbalanced by changes in temperature.

The displacement transducer was calibrated in place by moving the working piston to the zero clearance position and shifting the recording pen of the oscillograph to the outermost chart line. The gain of the amplifier was then adjusted so that when the piston was backed off 4 in. (in this investigation, the pressure build-up occurred within 4 in. of zero clearance) the pen traversed the chart width of 40 divisions making each division equivalent to one-tenth of an inch. This value was checked at various positions of the working piston and the displacement transducer was found to be linear.

This system gave a permanent record of the pressure and displacement. Although it was not used in this investigation, an electrical integrator could be connected to the amplifiers in place of the oscillograph. The integrator would give the area under the pressure vs. displacement curve and, consequently, the energy required for producing a pellet.

. . . Glass-Fiber Plastics

(Continued from page 339)

without the expense and difficulties encountered with a full-scale unit. Distorted models cause no increase in difficulty over true models when considering the use of model analysis.

3 Agreement between model and prototype is within acceptable differences between measured and estimated values for the phenomena observed. The results of the model study indicate fibrous-glass reinforced plastic resins can be used with confidence in farm building design and construction.

4 The structural test floor with the hydraulic loading system permits convenience, accurate control and rapid variation in load application to any structure that is relatively narrow in dimension perpendicular to the plane of the applied loads. With the whiffletree loading shoes, no difficulty was experienced in testing a section of two foot depth.

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. . . Asphalt-Burlap Linings

(Continued from page 342)

it attractive is the possibility for reconditioning it. It is anticipated that after a time, possibly 5 to 10 years, the surface of the lining will have deteriorated to a degree. When that time comes, it is proposed to apply a light application of asphalt to the surface, add another layer of burlap and a final light application of asphalt with the expectation that the reconditioned liner will be essentially as good as new.

Little work has been done on mildew proofing of the burlap. It is believed that durability of the lining might well be extended considerably by the use of improved proofing methods. It is not inconceivable either that the asphalt component of this lining can be improved, and it is anticipated that some such investigations will be undertaken. The results of our preliminary investigations nonetheless seem to warrant favorable consideration of the built-up asphalt lining in its present state of development, particularly in areas where concrete aggregate is not available and an exposed lining is desirable.

. . . Wheelus Barriensis

(Continued from page 306)

pears, cockles and muscles alive, alive, oho and many other substances, its primary use has been in the collection, transportation and disposal of manure. The question "should it be piled high or deeper" has long been the subject of discussion. Now it is being investigated experimentally in the laboratory. There is a conspicuous lack of information on this and such important questions as, from which side should the barrow be loaded, should it be pulled or pushed, at what angle should the operator lean forward when pushing the barrow for different loads and many other questions. In fact the lack of scientific knowledge in this area makes it extremely remarkable that people have been able to use wheelbarrows at all. It is indeed a fruitful subject for investigation and much more work needs to be done in this area.

Soil Compaction Bibliography

AN Annotated Bibliography on Soil Compaction consisting of over 600 references with a short description of each reference and complete with subject index has been published by the American Society of Agricultural Engineers. The publication is a contribution of the Bibliography Subcommittee of the Soil Compaction Committee of ASAE, with representation from the Soil Science Society of America. Copies are available at $1.50 each ($1.00 to ASAE members). Quantity price for 25 copies or more is $1.00 each. Orders with remittance may be sent to ASAE, 420 Main St., St. Joseph, Mich.

Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. ASAE members may obtain copies of these papers without charge by returning order forms supplied upon payment of membership dues. Non-members, and members requesting more than 10 copies, may purchase papers at 50 cents each to cover carrying charges from the American Society of Agricultural Engineers, St. Joseph, Mich.

Hay Pelleting from the Manufacturer's Point of View, by C. B. Richey, Tractor and Implement Division, Ford Motor Co., Birmingham, Mich. Presented at the Pacific Coast Section Meeting, Asilomar, Calif. February 1959. Paper No. **PC 59-7.**

The author of this manuscript considers hay pelleting from the standpoint of its advantages as well as problems with regard to field processing, storing and feeding costs. He believes that if the farmer is willing to invest in a completely mechanized feeding set-up which is many times that required for minimum bale storage, the pellet will eclipse the popularity of the bale. In conclusion he expresses his view that if history repeats itself, the farmer will invest more money in order to reduce labor and effort in the field and farm yard operations, with field pelleting becoming an accepted practice. The paper contains a table of comparative variable harvesting costs for baling and pelleting, based on 4 T/hr rate and 400 tons per year, and comparative pressure charts. A chart comparing cost of variable items in harvesting and storing of pellets and bales, dollars per ton, is also included.

Soil Moisture for Irrigation—A New Approach for Describing, by John L. Merriam, associate professor, irrigation and water, division of agricultural engineering, California State Polytechnic College, San Luis Obispo, Calif. Presented at the 37th Annual Meeting of the Pacific Coast Section, Asilomar, Calif. Paper No. **PC 59-11.**

In this manuscript a method of describing the feel-appearance, soil moisture relationship directly in terms of moisture deficiency is presented with a facilitating chart. The method, the author believes, eliminates several steps used in all previous procedures thereby simplifying the determination of the amount of water needed to replenish the root zone. The accuracy of the procedure has been tested for several years. With limited practice, estimates of moisture deficiency within 12" per ft of the true value are consistently obtained. By using soil moisture deficiency rather than the usual terminology of amount of moisture in the soil, confusion resulting from describing moisture in soils of different textures (available moisture range) is eliminated.

Weeds—A Problem for the Agricultural Engineer, by Austin A. Armer, agricultural engineer, Spreckles Sugar Co., Woodland, Calif. Presented at the 37th Annual Meeting, ASAE Pacific Coast Section, February 1959. Paper No. **PC 59-1.**

The text of this paper deals largely with the struggle the sugar beet industry continues to face with the weed problem. Weeds, the author states, cost the agriculture of California 0.3 billion dollars annually—20 percent of the 1.5 billion dollar annual value of the farm product of the State of California. On the promise that total weed eradication is economically impossible, the sugar beet industry vigorously pursues a policy of coexistence with them. Many methods and machines, he says, have been developed which supplement standard cultural practices of weed control in the fields; others which cope with weed contamination of sugar beets within the sugar processing factories. These methods and machines, the author believes, represent the true purpose of agricultural engineering with their constant improvement and ultimate perfection presenting a challege to the profession.

Aircraft For Agriculture—Past, Present, and Future, by George S. Sanders, president, Agricultural Aviation Engineering Co., Sunnyvale, Calif., and Robert Anderson, chief project engineer, Hiller Aircraft Corp., Palo Alto, Calif. Presented at the 37th Annual Meeting of the Pacific Coast Section, February 1959. Paper No. **PC 59-8.**

In this paper the authors begin their discussion with a review of the origin of agricultural aviation. Progress in the field of aerial application, the authors state, has been aided greatly by the introduction of more effective chemicals with physical characteristics suitable for aircraft use and by engineering efforts to provide more suitable aircraft and dispersal equipment. The authors also point out that the agricultural engineer has an important contribution to make in agricultural aviation of the future.

Nitrogen Vaporization Loss in Sprinkler Irrigation, by Kenneth A. Koch, associate agricultural engineer, Agricultural Extension Service, Louisiana State University, Baton Rouge. Paper presented at the Winter Meeting of ASAE in Chicago, December 1958, on a program arranged by the Soil and Water Division. Paper No. **58-511.**

An account of an investigation conducted to determine the loss of fertilizer through vaporization of a gaseous, a liquid, and a solid nitrogen fertilizer is given in this paper. The variables investigated were concentration of solution, distance from sprinkler, pH of the solution, nozzle pressure, and temperature of the solution.

Irrigation Water Management for Grain Sorghum, by M. E. Jensen and W. H. Sletten, agricultural engineers, Western Soil and Water Management Research Branch (ARS), USDA, Bushland, Texas. Paper presented at the Winter Meeting of the ASAE in Chicago, December, 1958, on a program arranged by the Soil and Water Division. Paper No. **58-513.**

The results of a three-year study of irrigation and fertility levels on hybrid grain sorghum are considered in this paper. Tests show the need of maintaining adequate soil moisture during the boot through the soft dough stage of growth for efficient use of rainfall and irrigation water. Soil moisture extraction patterns and evapo-transpiration rates on several row spacings and planting rates for various stages of growth are also presented.

Soil Compaction by Traffic, by William R. Gill, soil scientist, National Tillage Machinery Laboratory, Auburn, Ala. Paper presented at the Alabama Section meeting of ASAE in Montgomery, April 1958. Paper No. **58-342.**

The author discusses soil compaction as an increasing problem as a result of heavier equipment being used on farms, the increased amount of traffic and the shrinkage forces of drying. He also states that 40 years of cultivation in the prairie soils of Ohio have resulted in an increase in the density of the soils of 20% and a decrease in the porosity of 10%, much of which was caused by early disturbances of the soil, decreased returns of organic matter resulting from the removal of the native grasses, as well as the compacting effects of traffic over the soil. While the first two of these factors are minimized, he states, the compaction by traffic will increase in the years ahead so that research must be conducted to determine to what extent the consequences will affect the productivity of agricultural soils.

The Teflon-Covered Moldboard Plow, by Roy T. Tribble, agricultural engineer, Pineapple Research Institute, Honolulu, Hawaii. Presented at the Winter Meeting of ASAE in Chicago, December 1958, on a program arranged by the Power and Machinery Division. Paper No. **58-615.**

This paper reports on a search for materials to better adapt moldboard plows for handling troublesome soils. It is especially concerned with Hawaiian soils of volcanic origin, composed of 85 percent clay separates, and, if not puddled at time of tillage, have good granular structure and low shear strength. In Hawaii much time and effort have been expended in developing a plow to overcome the sticky soil adhering to the standard moldboard and at the same time invert the large quantities of crop residue.

The steel moldboard of standard type has been removed or covered with such materials as glass, plaster of Paris, plexiglass, slats (steel, wood, glass, bronze, and lucite), and stainless steel with no appreciable improvement in operation. Other types of plows, including one with heated moldboard, screw plows (both horizontal and vertical), Storey plow, and powered-belt moldboard plow, have been used.

From preliminary trials using a 14-in. general purpose bottom, the use of Teflon as a moldboard cover to improve scouring appeared practical. After investigations concerning plowing depths, speeds, etc. a 32-in. general purpose bottom (patent pending) was designed and constructed to observe scouring and the endurance of Teflon sheets on a plantation scale. It is so designed that a removable shin and share are used to compress the leading edges of the Teflon sheet against the frog, thereby utilizing the full tensile strength of the Teflon to overcome the forces exerted by the soil as it passes over the moldboard surface. The total draft is reported to be considerably lower than other types of plows.

Several plastics of the same general families of polymers have been tested as a moldboard covering either in the laboratory or under field conditions. Due to high costs or low endurance, other materials in this group appear less attractive than the Teflon products.

The moldboard coverings from Teflon products may be attached by Epoxy resins, bolts, or a combination of the two. The use of bolts with the leading edges of sheet tucked under the share and shin has been most successful.

Student Branch Wins Top Award at Engineering Open House

The Illinois Student Branch of ASAE at the University of Illinois entered its own exhibit for the first time at the annual Engineering Open House conducted at the University and won top honors. The exhibit consisted of a CID Air Structure, 40 by 100 feet, erected on a parking lot and strategically placed from the standpoint of spectator traffic. As a result, an estimated 11,000 people, mostly high school students, visited the agricultural engineering exhibits. In addition, the agricultural engineering students won the I SEE Award for the best exhibit area in the entire event.

Agricultural Engineering Senior Is CSU Honor Engineer

Andrew M. Brown, student member of ASAE, has been named the 1959 Honor Engineer at Colorado State University and recipient of the Honor Engineer silver medal, highest honor given a CSU engineering student. Andrew Brown is president of the Colorado Student Branch of ASAE and editor of the "Slide Rule," CSU engineering magazine.


A. M. Brown

A second agricultural engineering senior, Vincent V. Salomonson, was runner-up and was presented with an achievement certificate.

EVENTS CALENDAR

June 15-19 — The 67th Annual Meeting of the *American Society for Engineering Education,* University of Pittsburgh, Pittsburgh, Pa. The Agricultural Engineering Division will hold a session on June 18.

June 17-20 — The National Society of Professional Engineers, Commodore Hotel, New York City. For further information contact the NSPE, 2029 K St., N.W., Washington 6, D.C.

June 22-26 — *American Society for Testing Materials* and the *American Society for Engineering Education Symposium on Education in Materials,* Atlantic City, N. J. For details contact American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

June 28—July 3 — The Pennsylvania State University's *Plastic Engineering Seminar,* Pennsylvania State University, University Park, Pa. Additional information is available from the Extension Conference Center, The Pennsylvania State University.

June 29—July 25 — *6th International Vacation Course,* Technische Hochschule Stuttgart, Stuttgart, Germany. For further information contact Sekretariat des Internationalen Ferienkurses der Technischen Hochschule, Stuttgart, Huberstrabe 16, Germany.

52nd Annual Meeting of ASAE

The 52nd Annual Meeting of ASAE will be held June 21-24 at the New York State College of Agriculture on the Cornell University campus in Ithaca. Advance registration cards, hotel reservation forms and programs have been mailed to ASAE members. Non-members interested in attending the meeting should communicate with the central office of the Society at St. Joseph, Mich., or C. W. Terry, chairman of ASAE Meetings Committee, Riley-Robb Hall, Cornell University, Ithaca, N. Y., for information on accommodations and the program of the meeting sessions.

Among the highlights of the program will be a Sunday evening opening get-together and buffet dinner; the Monday evening barbecue at Taughannock State Park; and the special awards and entertainment program on Wednesday evening.

A summary of the technical program appeared in the May issue of AGRICULTURAL ENGINEERING. Following are details concerning the special programs for the Public Lands and Public Works group, the Extension Seminar, and the Student program:

Public Lands and Public Works

The Public Lands and Public Works program will open with a Monday morning session using as its theme "Fire—Its Uses and Control." In connection with this subject the following papers will be presented: "The Interstate Compact Device in Cooperative Forest Fire Control," by A. S. Hopkins, Northeastern Forest Fire Protection Commission; "Range Fires on the Public Domain," by C. P. Mead, Bureau of Land Management, USDI; "Advances in the Use of Helicopters for Fire Suppression," by A. G. Brenneis, Forest Service, USDA; "New Developments in Forest Fire Control Applicable to Range Fires," by R. F. Wagle, University of Arizona; "Prescribed Burning as a Tool of Forest Management in New Jersey," by Gordon Bamford, Department of Conservation and Economic Development.

The Monday afternoon session will feature irrigation and drainage and will be a joint meeting with the Soil and Water Division. For details on the subjects to be discussed see the Monday afternoon program for the Soil and Water Division.

A joint session with the Soil and Water Division will again be held Tuesday morning on the subject of hydrology. For details on the papers to be presented at this session see the Tuesday morning program of the Soil and Water Division.

The theme of the Tuesday afternoon session will be "utilizing soil surveys in construction." Papers to be presented will include: "Basic Nature of Soil," by Roy Simonson and B. L. Matzek, SCS, USDA; "How Soil-Engineering Data Are Obtained by the National Cooperative Soil Survey," by A. C. Orvedal, SCS, USDA; "Utilizing Soil Surveys in Highway Construction," by J. R. Chaves, Bureau of Public Roads, U.S. Department of Commerce; "Engineering Uses of Soil Surveys in Residential Construction," by E. F. Henry, Federal Housing Administration; and "Utilizing Soil Surveys in Soil Conservation Engineering," by C. J. Francis, SCS, USDA.

The final session of the Public Lands and Public Works group, on Wednesday morning, will be held jointly with the Soil and Water Division. For details of the discussions to be presented on soil erosion at this session see the Soil and Water Division Wednesday morning program.

Surpasses Quota for Motion Picture

The Quad City Section of ASAE is the first section to over-subscribe its quota for the ASAE motion picture. Shown above is G. Harvey Shriver *(right),* retiring Section treasurer, as he presents a check that put the Section over the top to Robert G. Morgan, chairman of contributions from ASAE Sections, in presence of Bruce A. Genzel, retiring section chairman. Employing several successful ideas in its fund-raising program, the Section actually surpassed its quota by more than 20 percent. Persons interested in methods used in the Section's fund-raising program may contact Robert G. Morgan, Timken Roller Bearing Co., 1518 Fifth Ave., Moline, Ill.

Other ASAE Sections that have already met quotas in full are Pennsylvania, Tennessee and Washington, D.C. (Photo by Lant, Moline Daily Dispatch.)

Extension Seminar

An extension seminar will be held on Thursday morning with E. D. Markwardt, Cornell University, chairman, committee on extension, presiding. M. C. Bond, Cornell University, will present "Some of the Challenges Facing Extension Engineers." He will be followed by a panel and group discussion of industry extension programs. The panel will include E. D. Anderson, Stran-Steel Corp., as moderator; Maurice Burgener, Portland Cement Assn.; Frank Reynolds, U.S. Steel Corp.; Clifford Hinkle, Standard Oil Co. (Indiana); and John Hosford, Pump Manufacturers Assn. Purposes and methods of in-service training of county agents will be discussed by C. Harrington, Cornell University.

H. S. Pringle, Extension Service, USDA, will be toastmaster at the get-acquainted luncheon on Thursday noon.

The Thursday afternoon session of the seminar will be presided over by S. P. Lyle, Agricultural Programs Division, Extension Service, USDA. Group discussions on effective county agent training will be led by: H. S. Pringle, Federal Extension Service; R. L. Maddex, Michigan State University; H. M. Ellis, North Carolina State College; W. Bowers, University of Illinois; and A. V. Krewatch, University of Maryland. A. H. Schulz, North Dakota Agricultural College; C. S. Winkelblech, Cornell University; R. O. Gilden, Federal Extension Service; D. G. Jedele, University of Illinois; and M. R. Warner, University of Maine will give group reports. A report by the committee on extension will conclude the seminar.

Student Program

The Student Program will open Monday morning, with Robert Mensch, Iowa State College, president, National Council of ASAE Student Branches, presiding. The

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ASAE MEETINGS CALENDAR

JUNE 21-24 — 52ND ANNUAL MEETING, Cornell University, Ithaca, N. Y.

September 1-3 — NORTH ATLANTIC SECTION, University of Maryland, College Park, Md.

October 2-3 — KENTUCKY SECTION, Mammoth Cave, Ky.

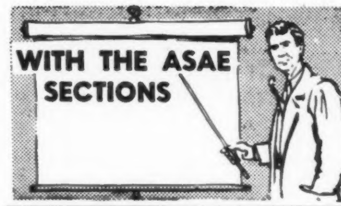
October 14-17 — PACIFIC NORTHWEST SECTION, Ephrata, Wash.

October 22-23 — ALABAMA SECTION, Enterprise, Ala.

October 24 — MICHIGAN SECTION, Michigan State University, East Lansing.

December 16-18 — WINTER MEETING, Palmer House, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.



Mid-Central Section

The Mid-Central Section meeting was held at St. Joseph, Mo., April 3-4 with a registration of 137, including 46 student members and 12 visitors.

New officers elected for the coming year include: chairman, E. A. Olson, University of Nebraska; vice-chairmen, L. B. Altman, Iowa State College, R. I. Lipper, Kansas State University and J. S. McKibben, University of Missouri; secretary-treasurer, K. L. McFate, University of Missouri; nominating committee, F. C. Fenton (chairman), Kansas State University, G. W. Steinbruegge, University of Nebraska, and T. E. Hazen, Iowa State College.

Student officers elected for the new year are as follows: Carl Carpenter (University of Missouri), president; Bob May (University of Missouri), vice-president; Waldo Lang (Kansas State University), secretary-treasurer; branch vice-presidents, Duane Howell (Iowa State College), Hal Judy (Kansas State University), D. L. Lees (University of Nebraska), and Raymond Meyer (University of Missouri).

The opening program on Friday afternoon included panel discussions on small watershed activities and state farm electric programs. A number of the group attended the bowling session in the afternoon.

Dr. E. G. McKibben, director AERD, ARS, USDA, and president of ASAE was the speaker for the Section Banquet on Friday evening. Fred C. Fenton, Kansas State University, spoke during the Saturday noon luncheon. His subject, "India as I Saw It," was highlighted by slides illustrating his two years as a consultant to Indian agriculture.

Papers presented at the Saturday morning session included discussions by C. L. Callum, J. H. Pedersen, L. E. Donegan and R. A. Saul. Student paper awards were presented to Don C. Anderson, Kansas State University (first place) and to Dean M. Ruwe, University of Nebraska.

Connecticut Valley Section

The Connecticut Valley Section met May 25 at Worcester County Electric Co., Worcester, Mass., with dinner being held in the company cafeteria. Robert L. Zahaur, manager of application engineering in the Commercial Engineering Department, Westinghouse Lamp Division, Bloomfield, N. J., was featured speaker. Mr. Zahaur is a graduate of Case Institute of Technology and is currently working with Dr. George Taylor of Rutgers University on experiments using lights to control growth of vegetable plants. His topic was "The Use of Electric Illumination in Raising Flowering Plants."

Hawaii Section

Twelve members and three guests were present at the Hawaii Section Meeting, held April 24, following a tour of the Hawaii Meat Co. During the business meeting it was voted that at least two section meetings be held each year with a dinner meeting in the month of February for the election of new officers and other section business. The second meeting to be held in October is to be devoted to the presentation and exchange of technical information.

North Atlantic Section

The North Atlantic Section will hold its 35th Annual Meeting September 1-3 at the University of Maryland. The first morning will be devoted to a general session with L. H. Skromme, president of ASAE and chief engineer, New Holland Machine Co.; W. C. Libby, dean of agriculture, University of Maine; and J. L. Butt, executive secretary of ASAE, as speakers.

Concurrent sessions will be held Tuesday afternoon. Talks to be given during the Farm Structures session include discussions on the Herringbone milking parlor, poultry calorimeter studies on caged laying hens at various temperature levels, measurement of solar heat energy to poultry buildings, economics of pork production relative to farm structures, and farm buildings as part of a system. The Power and Machinery group will discuss tillage at the crossroads, nitrogen on grassland, machinery and methods for establishing forage crops, and advances in mower design. The Soil and Water group has scheduled talks on winterizing hydrologic research equipment, design of earth spillways for small watershed structures, two-stage inlets, and small watershed program progress. The Electric Power and Processing program for Tuesday afternoon includes a luncheon and a discussion and observation of electric power and processing research activities at Beltsville Research Center.

A barbecue will be held at 6:30 p.m., Tuesday evening.

A Farm Structures and Power and Machinery joint session to be held Wednesday morning will feature talks on the field hay pelleter, some aspects of storing, auger conveyors, and random handling and drying of bales. The Electric Power and Processing group has scheduled Wednesday morning discussions on dairy water heater performance, and low-starting-current single-phase motors. The Soil and Water program covers land smoothing for improved grassland farming, land forming research in Virginia, and sprinkler irrigation for frost protection.

A general session to begin at 1:30, Wednesday afternoon, will be on the role of agriculture in mutual security, to be considered by Colonel John C. Lackas, U.S. Army, Industrial College of Armed Forces, and a discussion of agricultural engineering implications of Colonel Lackas' address, by W. M. Carleton, assistant director, AERD, ARS, USDA.

The banquet will be held at 7:00, Wednesday p.m. Toastmaster will be F. L. Rimbach, and Charles B. Shuman, president,

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Shown during the 12th Annual Meeting of the Mid-Central Section are: *(left to right)* G. L. Kline, secretary-treasurer; C. LeRoy Day, retiring chairman; Dr. E. G. McKibben, president of ASAE and banquet speaker; and E. A. Olson, program committee chairman and new section chairman

The Armco Drainage & Metal Products, Inc., Middletown, Ohio, served as host for the February meeting of the Ohio Section. *(Left to right)* Charles L. Hahn, new section chairman; Robert Harbage, outgoing section chairman; Warren L. Roller, outgoing section secretary; Dr. Bedi, chairman of the agricultural engineering department of the Government Agricultural College, Ludhiana, India; and Donald W. Richter, Armco sales engineer. Dr. Bedi is studying soil and water conservation engineering at Ohio State

Blaine F. Parker has been named head of the agricultural engineering department of the University of Kentucky. He joined the agricultural engineering staff in 1957 and has been serving as acting head of the department since August 1958 following the resignation of D. T. Kinard.

Born in Gaston County, N.C., in 1924, Dr. Parker attended Berea College, Berea, Ky. After 3 years of active duty with the U.S. Air Force, he continued his education at Virginia Polytechnic Institute, Blacksburg, Va., where he received a B.S. degree in agricultural engineering in 1950, and an M.S. degree in agricultural engineering in 1952. He later received a Ph.D. degree in agricultural engineering from Michigan State University.

After his graduation from Virginia Polytechnic Institute in 1950, Dr. Parker was placed on the Institute staff as an instructor in the agricultural engineering department. While working for a Ph.D. degree at Michigan State University he did graduate research work for two years. In 1954 he joined the staff of North Carolina State College as an assistant professor in the agricultural engineering department, where he remained until his appointment at the University of Kentucky.

Walter F. Strehlow *(right)*, chief engineer of the Farm Equipment Division at the West Allis (Wis.) Works, Allis-Chalmers Manufacturing Co., and member of ASAE since 1941 receives a "certificate of recognition" by U.S. Commissioner of Patents, Robert C. Watson, for his "ingenuity and outstanding contribution" to society through the medium of the U.S. Patent System. To be eligible for the award, made during the Milwaukee Patent Law Association's recent 25th anniversary meeting, the engineer must have 25 or more U.S. patents on his invention and developments. In addition to his U.S. patents, Mr. Strehlow has received more than 20 foreign patents, and now has numerous patents pending. All cover developments and inventions applicable to farm equipment. Included are patents on the drive-in cultivator, the power shift wheel, and torque tube construction for tractors. Similarly honored was R. C. Allen *(center)*, director of mechanical engineering.

Gerald E. Ryerson, conservation equipment engineer, has been appointed director of the Administration Services Division of the Soil Conservation Service, Washington, D.C. In his new position, he will have charge of watershed project contracting, purchasing, and similar services and will continue liaison work with the equipment industry.

In length of service, Mr. Ryerson is the third oldest employee still working for the Soil Conservation Service. He started with the Soil Erosion Service in November 1933 and helped start the Erosion Experiment Station at LaCrosse, Wis. At Coon Valley, Wis., he was the first project engineer of a soil conservation demonstration project in the United States. He was born in Huron County, Ohio, and is an agricultural engineering graduate, from Ohio State University.

Emmett A. Kimbrough, Jr. has been named as the consultant agricultural engineer to the University of Dacca, Dacca, East Pakistan by the Office of Foreign Programs, Texas A & M College. The Texas A & M College has a contract for providing technical assistance to the University of Dacca with the International Cooperation Administration, Washington, D.C.

Mr. Kimbrough is a native of Bolivar County, Miss., and received a B.S. degree from Mississippi State University in 1947. After graduation, he served as assistant farm manager in the Delta and as a veteran instructor in Prairie County, Ark., until September 1948, at which time he joined the staff of Mississippi State and Mississippi Agricultural Experiment Station as an instructor and assistant agricultural engineer, obtained an M.S. degree in agr. eng. in 1953 from Texas A & M. His duties have been in the field of irrigation and farm mechanization. He has taken a leave of absence with the rank of assistant professor from Mississippi State to assume this position in Pakistan.

Satish C. Grover, formerly with the Government of Bihar in India, is now assistant agricultural engineer with the Government of Rajasthan. In his new assignment he will be in charge of the Agricultural Department Central Workshop at Bharatpur, India.

Ralph L. Oyler has accepted a position as sales manager of the Indianapolis Branch of Massey-Ferguson, Inc. He formerly was connected with Corson Brothers, Inc., as general manager.

Robert A. Fulmer, who has been engaged in farming in Belvue, Kansas, since his discharge from the U.S. Air Force, has recently accepted a position with Starline Inc. of Harvard, Illinois.

S. V. Arya, formerly a lecturer in agricultural engineering at the Indian Institute of Technology, Kharagpur, India, has accepted an assistant professorship in the agricultural engineering department of the Institute.

Duncan E. Holt was recently transferred to the Louisville, Ky., office of International Harvester Co. Previously he held the position of district manager of farm equipment, at the company's Cincinnati, Ohio, sales office and district manager in Atlanta, Ga.

George W. P. Swenson, who has been located at Taunton, Mass., with the Mount Hope Machinery Co., advises that he has been transferred to Mount Hope Machinery Ltd. at Dartford, Kent, England.

B. F. Parker

G. E. Ryerson

Eugene P. Morgan advises that he is now connected with the Plantation Division of American Factors, Ltd. in Honolulu, Hawaii. Formerly, he was employed as a project engineer with the Hawaiian Sugar Planter's Assn. in Honolulu.

John A. Patterson, upon the termination of his present contract with the Sudanese government, has returned to "Chesterholm," Bardon Mill, Hexham, Northumberland, England. He has been working with the Ministry of Agricultural Engineering at Khartoum, Sudan, since early in 1958.

Dunrith Waund, Jr. has been transferred from the LeSueur, Minn., office to the Dayton, Wash., office of the Green Giant Co. In his new position he will be division agricultural engineer at the Blue Mountain Division of the company.

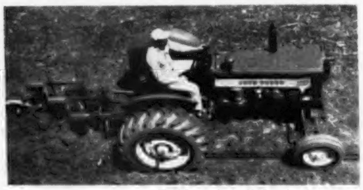
Franklin B. Wetherbe has recently returned to Montague, Mass., from Afghanistan. He has been teaching mathematics in the Afghan Institute of Technology at Kabul, Afghanistan, for the past two years.

NECROLOGY

John T. Pickett, civil engineer and surveyor, died May 3, 1959, of a rare lung disease. He was born in 1901 in Pickett, La., and although he had no technical education, he was outstanding in his field of design, water control, structural engineering and land surveying. From 1936 to 1940 he was employed as a project engineer with the Florida State Road Department. In 1940 he accepted a position as a builder and construction engineer where he remained until 1942 when he joined the U.S. Army Corps of Engineers as executive officer, 3rd Engineers District. In recognition of his services in this capacity he was the recipient of a legion of merit and Bronze Star Award. After his discharge from the armed services, he resumed his work as a self-employed civil engineer and surveyor. As an authority on the topography and composition of the Everglades he brought to his engineering practice in the area an intimate knowledge of its history and special conditions pertinent to efficient professional services. Professional duties in Louisiana and for El Hombre of the Dominican Republic varied his work from the flatlands of the Glades as did his building of airports in China and the Far East during World War II. Enthusiastic about the Glades, he was always available for endeavors in the civic, social and religious life of his community. He was a member of the Florida Engineering Society and a Senior member of the National Society of Professional Engineers. He also held membership in the Elks Club, American Legion and the Presbyterian Church. He is survived by his wife, Edna Bell, one daughter, Elizabeth, two sons, John, Jr., and Donald.

2 to 3-Plow Diesel Tractor

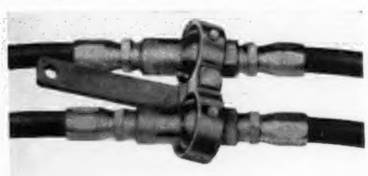
John Deere, Moline, Ill., has introduced a new 2 to 3-plow diesel tractor especially designed for handling drawn, 3-point hitch and PTO tools. It offers 21-in. crop clearance and will handle a moldboard plow with three 16-in. bottoms or other tools of proportionate size. It is powered by a



diesel engine of two-cylinder, two-cycle design. The engine delivers about 29 drawbar horsepower and about 32 belt horsepower. Regular features include adjustable front axle, single hydraulic control, manual steering, 3-point hitch with load-and-depth control, swinging drawbar, a 560-rpm transmission-driven power take-off and four-speed transmission.

Farm Hydraulic Coupling

Aeroquip Corp., Jackson, Mich., announces a new push-pull farm hydraulic coupling in three varied configurations and a swivel breakaway frame. The coupling was designed for easy connection and disconnection on all farm hydraulic systems with working pressures to 3000 psi. Three variations of the coupling are available to meet special requirements on all makes and



types of farm equipment. A swivel breakaway frame for use with these couplings simplifies mounting and alignment problems. Installed in the frame, couplings can swing 30 degrees in any direction, which virtually eliminates sidethrust as a source of coupling wear and leakage, since the coupling always pulls away exactly parallel to the pull. Damage to fluid lines is prevented, because the coupling is designed to disconnect under minimum stress.

Spinner Plow

Allis-Chalmers Mfg. Co., Milwaukee, Wis., announces its new 60 Series spinner plow, equipped with a spring-operated spinning device for changing from left-hand to right-hand bottoms, and vice versa, by tripping a lever from the tractor seat. The

plow is available with 14 or 16-inch quick-penetrating, self-sharpening bottoms, and spacing fore and aft between bottoms measures 21 inches for adequate trash clearance. Special equipment includes 16-inch notched coulters and steel or cast standing jointers. Beams are of spring steel construction.

Plastic Retainers

The Torrington Co., Torrington, Conn., announces the development of a fiber-glass-filled nylon retainer for its needle-thrust bearings. These plastic retainers are available in addition to the steel retainers now in use. Offered only in non-standard sizes, thrust bearings with plastic retainers are made to customers' specifications. The plastic material is practical for bearing up to 3-inch bore. The plastic retainers permit lower tooling costs for new sizes. The company's conical needle-thrust bearing is produced only with the plastic retainer. This bearing, capable of taking both thrust and radial loadings, eliminates the need for a radial bearing in certain applications.

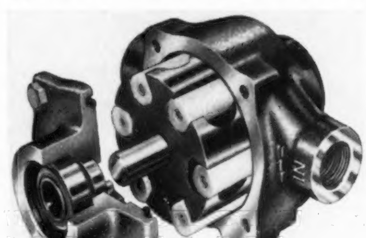
Tree Tie Machine

Besler Corp., Berkeley, Calif., announces a unique tree-tying mechanism, the A-S-K tree tie machine, which is claimed to double the speed of tree tying or propping. This device is a lightweight tying mechanism attached to the end of an aluminum pole of variable length (up to 25 feet). In addition, there is a sliding jack on the pole which is used to push up on the lower limb during the tying of the lower knot. The rope feeds from a small knapsack slung over the operator's shoulder. With each tie, the rope is wound into the mechanism in a certain manner. The mechanism is then raised to the upper limb and a sharp pull on the rope ties the knotted loop without pulling against the limb or shaking off fruit. The knot forms a loose loop to allow for growth; yet it cannot slip and choke the bark.

A-S-K tree tie

Sprayer Pump

Hypro Engineering, Inc., 700 39th Ave. N.E., Minneapolis 21, Minn., announces its new series 6600 sprayer pump which includes design innovations in the way of sealed ball bearings, detachable mounting base and tamper-proof seal relief porting. It is offered in either cast iron or corrosion and abrasion-resistant Ni-Resist materials. Equipped with nylon rollers and cartridge-type buna-N seals, the pump can be used



for insecticide and weed control chemicals. Leather seals may be substituted for use with soil fumigants and other aromatic chemicals. Interchangeable power take-off adapters are available to permit direct mounting of the pump from tractor PTO shafts, or a separate cast mounting base may be used when the pump is belt driven by motor or gas engine. At speeds up to 1200 rpm, it will deliver up to 20 gpm.

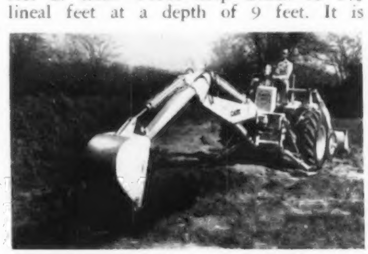
Crawler Tractor

International Harvester Co., 180 N. Michigan Ave., Chicago, Ill., announces a new 31 drawbar horsepower heavy-duty crawler tractor. Weighing 5600 lb, this tractor is powered by a 4-cylinder gasoline engine with 135-cu-in. displacement that develops 45 hp. A choice of heavy-duty standard drawbar or 3-point hitch equips this tractor to handle virtually all trail-behind implements as well as a wide variety of 3-point mounted equipment. It can be ordered with torque-amplifier drive or fast-reverser attach-

ment, and hydraulic systems to handle both mounted and trailing equipment. It is equipped with clutch disk brake planetary steering and it has five speeds forward, one reverse, and a speed range of 1.5 to 5.9 mph. It can be ordered with either 38 or 48-in. gage track with each track having four rollers and 66 in. of track-on-ground. Ground clearance is 12 in., and over-all height is 52 in. to the top of the exhaust pipe.

Digger

J. I. Case Co., Racine, Wis., announces a new digger for trenching, backfilling, loading and utility work, and is designed for digging at practical depths to 10 feet. It has a reach of over 15 feet, and sidecasts or loads into trucks up to 10 feet high. Without changing position, this unit will dig 14 feet of clean 4-foot deep trench or 6½ lineal feet at a depth of 9 feet. It is



equipped with individually controlled telescoping stabilizers to permit vertical trenching on side slopes up to 10 degrees. The hydraulic 180-degree swing is foot-controlled to speed dig-and-dump cycles by allowing the operator to work boom, crowd, and bucket while pivoting. The backhoe is quickly removed for installation of front or side mowers, or a score of quick-hitch tools for grading, landscaping, tilling, and specialized work.

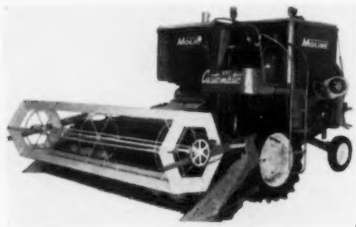
(Continued on page 350)

. . . New Products

(Continued from page 349)

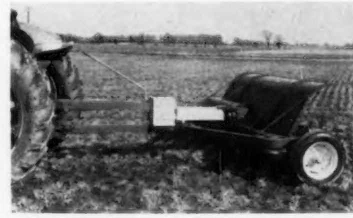
Self-Propelled Combine

Minneapolis-Moline Co., Hopkins, Minn., announces a new self-propelled combine of low-profile design. It is powered by a 6-cylinder, 67-hp engine and is equipped for hydraulic-power steering. The automatic-type clutch and transmission has 4 forward and 1 reverse gear. Variable sheaves provide for a wide range of ground speeds in each gear. The hydraulic power controls provide for ease of steering even on the roughest ground. Other features include power-adjusted wheels, chain-driven cylinder, self-adjusting raddle, one-lever concave adjustment, one-piece cutter bar, etc.



PTO Reverse Unit

Garber Seeders, Inc., St. Paris, Ohio, announce a new power take-off reverse unit which is operated from the tractor seat. This unit can be mounted on any tractor and connected to the power take-off by a flexible coupling to handle a variety of operations such as reversing the direction of snapping rolls on pull-type corn pickers, reversing and unwrapping the rolls on hay conditioners, reversing the direction of the auger on post hole diggers, and it can be used to reduce high PTO tractor speed to 550 rpm. It can also be mounted on a corn picker or hay conditioner and connected to the PTO shaft. The operating handle can be positioned in either of two ways for access from the tractor seat. The unit operates in oil, is driven through roller chain, and is reversed through gears.



Portable Low-Pressure Meters

Sparling Meter Co., Inc., 225 N. Temple City Blvd., El Monte, Calif., has introduced a new line of lightweight, portable low-pressure meters for use in open ditches, in field culverts, on well discharges, or where temporary metering is desired. It is constructed of aluminum alloy, and the entire meter weighs as little as 16 lb and may be transported easily by one man. The line consists of five units ranging from 4 to 12 inches in diameter, and from 16 to 40 lb in weight. Flows are registered as low as 60 to as high as 2000 gpm. Plastic propellers are used which withstand water temperatures of 100 F without damage.

Quick-Disconnect Coupler

The Bruning Co., Lincoln, Nebr., announces its new SP-500 quick-disconnect coupler which is so designed as to enable the user to connect or disconnect hydraulic lines at full operating pressure without sacrificing automatic breakaway characteristics. This coupler handles an extremely broad range of fluid mediums and has a wide operating temperature range, from —40 to +250 F. Operating pressures exceed 7500 psi. This coupler has full swivel action, absorbs torsional strains and stresses from adjacent components, and eliminates the need for swivel adapters.

(Continued on page 352)

HOW ARMCO COATED TUBING helps farm equipment designers

New steels are born at Armco

Sprayer manufacturer saves by changing from non-ferrous metal to Armco ZINCGRIP Steel Tubing for pump cylinders and syphon tubes.

Armco's family of coated tubing is an economical solution to many agricultural equipment design problems:

Armco ALUMINIZED STEEL Type 1 Tubing for applications involving a combination of heat and corrosion.

Armco ALUMINIZED STEEL Type 2 Tubing for protection against atmospheric corrosion.

Armco ZINCGRIP® Steel Tubing for corrosion resistance, particularly in the presence of moisture.

Typical applications for ZINCGRIP Tubing are the pump cylinders and syphon tubes in these insecticide sprayers manufactured by Universal Metal Products Company, Saranac, Michigan. Company officials point out that this special tubing provides the necessary corrosion resistance for these parts.

Weld Bead Removed

All special Armco Tubing grades are coated with zinc or aluminum. The outside weld bead is removed and the coating replaced by a special metallizing process. When a smooth interior surface is important, all Armco Tubing can be ordered with the inside weld rolled down.

For complete information on sizes, gages, and shapes of tubing available, just write Armco Steel Corporation, 2069 Curtis Street, Middletown, Ohio, for a copy of our booklet, "Why Designers Specify Armco Coated Tubing."

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

. . . New Products

(Continued from page 350)

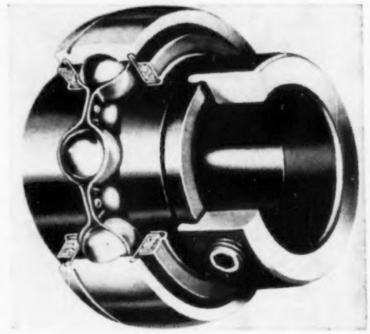
Pickup for Combines

Innes Co., Bettendorf, Iowa, announces a pickup attachment for combines incorporating the multiple-belt principle developed

by the company. The unit features long fingers staggered to cover every two inches, which completely disappear, and is both full floating and fully flexible from end to end. Large size pneumatic tires on self-aligning caster wheels are used.

Collar Lock Unit Bearings

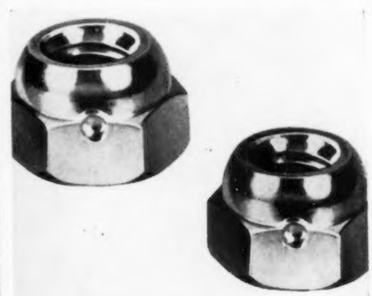
Hoover Ball and Bearing Co., 5400 S. State Rd., Ann Arbor, Mich. announces eccentric collar-lock machine-unit ball bearings equipped either with spherical seat for automatic self-alignment or straight outer diameters for more rigid, accurate shaft location. They are designed for easy adaptation to all types of housings requiring self-contained ball bearings. The collar, which secures the unit to the shaft, is a self-tightening, eccentric type that provides easy and positive locking upon installation.



All units are factory-lubricated and equipped with three-piece combination felt seals to retain lubricant and exclude contaminants. The bearings are offered either sealed for life or with lubricant channels in the outer bearing to provide for relubrication. These bearings are available in 32 shaft sizes from ¾ to 2 15/16 in.

Open-End Locknuts

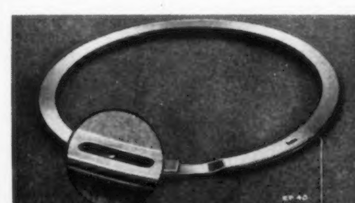
Russell, Burdsall & Ward Bolt and Nut Co., 100 Midland Ave., Port Chester, N. Y., announces introduction of its open-end locknuts of acorn design. Two stakings in the nut side distort threads slightly to lock the



nut to the screw by prevailing torque. Being all metal and one piece, they cost substantially less than other locking-type nuts. They are produced in both steel and aluminum in No. 10, ¼-inch and 5/16-inch sizes.

Retaining Ring

Ramsey Corp., 3693 Forest Park Blvd., St. Louis 8, Mo., announces a self-locking retaining ring that automatically locks when centrifugal force is applied. This product is said to be specially designed for high rotative applications or for applications where dirt or other foreign material tend to force



the retaining ring out of its groove. It is manufactured from flat spring steel, coiled on edge to effect a 360-degree retaining surface. The self-locking feature consists of two slots and two raised tabs which automatically lock when outward pressure is exerted on the ring.

New section officers elected at the April 24 meeting of the Quad City Section are shown *(left to right)* William M. Adams, International Harvester Co., East Moline Works, treasurer; Martin A. Berk, John Deere Spreader Works, secretary; G. Harvey Shriver, Deere & Co., vice-chairman; Robert B. Skromme, J. I. Case Co., Bettendorf, Iowa, chairman of nominating committee; John W. Ackley, John Deere Planter Works, chairman; Robert G. Morgan, Timken Roller Bearing Co., Moline, vice-chairman; and William L. Stevenson, J. I. Case Co., Rock Island Works, member of nominating committee. Third member of the nominating committee, Harold S. Seeber, International Harvester Co., East Moline Works, was not present. (Photo by Lant, Moline Daily Dispatch)

. . . With ASAE Sections

(Continued from page 347)

American Farm Bureau Federation, will be the speaker.

A tour of the Agricultural Research Center at Beltsville, Md., including the Home Economics Research facilities and the Beltsville Kitchen, is scheduled for Thursday.

Iowa Section

The Meredith Publishing Co. served as host and treated 52 members and guests to a free meal during the Iowa Section meeting held May 22 in Des Moines. Kenneth W. Snyder of Aubrey, Finlay, Marley and Hodgson, Inc., Chicago, discussed the opportunities and benefits to agricultural engineers in the field of technical journalism. Slides of typical farm equipment advertisements served to illustrate his presentation. In the second portion of the meeting Earl K. Larson, managing editor of *Successful Farming*, described the company's publications and conducted a tour of the Meredith plant. Included in the tour was an explanation of a $30,000 plastic model of a new plant now under construction.

During the business meeting the following new officers were elected: Robert M. Tweedy, chairman; Leon F. Charity, first vice-chairman (program); Eldon M. Collins, second vice-chairman (publicity); Donnell R. Hunt, third vice-chairman (membership); and Ronald K. Leonard, secretary-treasurer. Landy B. Altman, Jr., Dale M. Gilbert, and Leo B. Cheatum were elected to serve on the nominating committee.

Quad City Section

A total of 180 members and guests attended the Annual Meeting of the Quad City Section April 24 which began with a tour of the Rock Island Arsenal in the afternoon followed by a speech by Col. Daniel L. Hine, commanding officer, Rock Island Arsenal, on the development of new products and processes at the Arsenal. The evening program consisted of a talk with illustrations by W. J. Adams, Jr., assistant manager Central Engineering, Food Machinery & Chemical Corp. His title was "Steering and Traction Characteristics of Rubber-Tired and Crawler Vehicles."

During the business meeting the following new officers were elected: chairman, J. W. Ackley, John Deere Planter Works; vice-chairmen, G. H. Shriver, Deere & Co., and R. G. Morgan, Timken Roller Bearing Co., Moline; secretary, M. A. Berk, John Deere Spreader Works; treasurer, W. M. Adams, International Harvester Co., East Moline Works; nominating committee, R. B. Skromme (chairman), J. I. Case Co., Bettendorf, Iowa, W. L. Stevenson, J. I. Case Co., Rock Island Works, and H. S. Seeber, International Harvester Co., East Moline Works.

. . . 52nd Annual Meeting

(Continued from page 346)

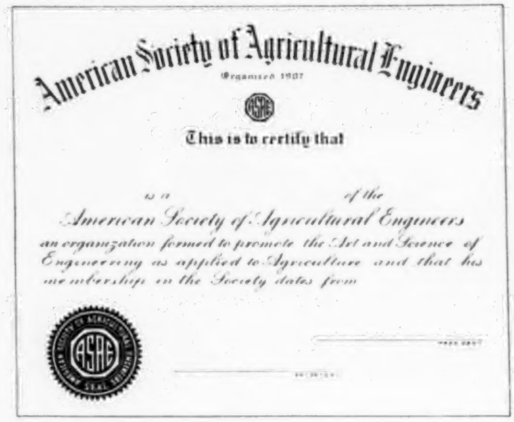
program will begin with a "Welcome to New York" followed by the roll call of student branches. Presentation of the winning papers in the ASAE Student Paper Competition and an address by E. G. McKibben, president of ASAE, will conclude the Monday session.

Richard Holdren, Ohio State University, 1st vice-president, National Council of ASAE Student Branches, will preside over the Tuesday morning meeting. The annual report from ASAE Headquarters on Student Branch affairs will be given by J. L. Butt, executive secretary of ASAE, and a panel discussion on interpretations, experiences and problems in the organization and operation of student branches will follow. R. A. Palmer, assistant secretary and treasurer of ASAE, will be the moderator for the panel of students from a number of institutions. P. N. Doll, Missouri Society of Professional Engineers, will speak on a Greek letter honor society for the undergraduate curriculum. Nomination of 1959-1960 officers for the National Council of ASAE Student Branches will conclude this session.

Tuesday evening there will be an FEI complimentary Student Dinner for student representatives and faculty advisers of ASAE Student Branches.

A review of the 1959 FEI Trophies Competition will be given on Wednesday morning by D. H. Daubert, J. I. Case Co., chairman, ASAE committee on FEI Trophies. A feature talk will be given by T. E. Clague of Aubrey, Finlay, Marley, and Hodgson Advertising Agency, on "Wanted: Engineers for Atom-age Agriculture." The election of officers for 1959-1960, National Council of ASAE Student Branches will bring the student program to a conclusion.

ASAE Membership Certificate



The official ASAE Membership Certificate, available to ASAE members only, measures 10¾ by 14 inches. It is engraved on heavy parchment paper and is suitable for framing. The member's name, grade of membership, and month and year of admission to the Society are engrossed by hand. The certificate is signed by the President and Secretary and bears the official (gold) seal of the Society. The price of the certificate, including engrossing, is $3.00. Order direct from

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
P.O. Box 229, St. Joseph, Michigan

Who Should Join ASAE

If any one of the following descriptions covers your present work:

- **Development, design, and application of farm tractors and implements and their components**
- **Design and improvement of farm buildings**
- **Engineered improvements for soil and water conservation and use**
- **Creating applications for electricity in farm practice and living—**

then you can derive much benefit from membership in ASAE, and the Society cordially invites you to make application. For further information write

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
St. Joseph, Michigan

MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Power Transmission Bulletin

T. B. Wood's Sons Co., Chambersburg, Pa. — An 8-page, letterhead size catalog covering company's complete line of sheaves, variable-pitch sheaves, V-belts, flat-belt pulleys, pillow blocks, flange units, takeup bearings, couplings and timing-belt drives.

Increase Chore Efficiency

LML Engineering & Mfg. Corp., Columbia City, Ind. — A 60-page booklet which gives data compiled by Cornell University on the delivery capacity of various size augers, the heighth and horizontal distance feed can be conveyed, and lists in fractions the horsepower requirement per each 10 ft of conveyor tubing. Illustrated by pictures and drawings showing various units of equipment needed and how to install economically and for maximum efficiency. Price 30 cents.

Pearlitic Malleable Castings Handbook

Malleable Research and Development Foundation, Granville 1, Ohio — A 76-page handbook which furnishes an introduction to pearlitic malleable and supplies reference to the latest information and data on this relatively new material. Four chapters cover introduction to the material, castings, facts and figures for design, and applications. Three charts contain information necessary to translate basic design needs into final pearlistic malleable specifications. Free to persons responsible for materials specification or selection.

Moisture Meter Circular

Industrial Instruments Inc., 89 Commerce Road, Cedar Grove, Essex County, N. J.—This illustrated folder explains what the BN-2 Bouyoucos Moisture Meter is, how it works, and what it means to the user; also included is "how to order" information.

Land Forming Booklet

The Farmhand Company, Hopkins, Minn. — A 16-page pamphlet, Land Forming for Profit, written especially for Farmhand by Ivan D. Wood, ASAE Life Fellow and leader in soil conservation and irrigation practices. This informative and interesting booklet covers the "land forming job" from the pioneer days to the modern day methods, and is well illustrated with drawings and photographs.

General Repair Kit

Williamson Adhesives, Inc., 8200 Kimball Ave., Skokie, Ill.—Specification manual describes Plastic Mastic repair kit for repairing floors, walls, ceilings, driveways, curbs, masonry, bricks, machinery, fixtures, tanks, pipes, plumbing, furniture, and for filling leaks, breaks, holes, and cracks.

Nylon Stock Shapes

The Polymer Corp. of Pennsylvania, Reading, Pa. — New 4-page bulletin BR-2e on Nylatron GS (molybdenum disulphide filled) nylon shapers presents the property advantages of the material used to expand the field for nylon in such applications as gears, rollers, bearings, washers, wear strips and pads, and other applications requiring long wear life and resistance to creep or cold flow. Physical property data and specific stock shape size availabilities are also included.

(Continued on page 367)

RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

Plans Available for Unit for Using Heat from Milk

A practical, electricity-saving system that uses heat from milk being cooled to preheat water either for washing dairy equipment or for warming the milkroom has been developed by an engineer of the U.S. Department of Agriculture (See January 1959 issue of AGRICULTURAL ENGINEERING).

The system employs heat given off through the condenser of a bulk tank refrigeration unit as milk is cooled. Enough heat is released from 200 gal of milk fresh from the cows to pre-heat 50 gal of water to 110 F. On the basis of 200 gallons of milk daily, this is a heat energy equivalent of about 4,000 kw-hr of electricity per year. The system can reduce by about 50 percent the amount of electricity used to heat water for washing dairy equipment.

M. Conner Ahrens of USDA's Agricultural Research Service at Pullman, Wash., developed the system in cooperation with the Washington Agricultural Experiment Station.

A pump, pipes, valves, and controls direct warmed water from the bulk tank condenser through a pre-heat tank to the storage tank of a conventional electric water heater. Then the water is heated to the usual temperature for washing dairy equipment. For warming the milkroom, the water is circulated through a standard radiator- and fan-type heater. A 400-gal bulk milk tank equipped with a 2-hp refrigeration unit was used in the experimental setup.

Mr. Ahrens listed cost of equipment for the wash water pre-heating system at about $175. An additional $150 to $200 would be needed for installation of the room-warming unit.

Although not available commercially, the package units can be built on the farm. Plans for constructing the units will be available after May 1 from the Agricultural Engineering Research Division at USDA's Plant Industry Station, Beltsville, Md., or from the State College of Washington at Pullman.

New Machine Speeds Tree-Fruit Harvesting

Faster harvesting of prunes, plums, and certain other small tree fruit — from 30 to 50 trees an hour — is now possible by three men using a unit of self-propelled catcher-conveyors designed by USDA and state agricultural engineers.

Two low-built catcher-conveyors placed side by side under a tree, and a tractor-mounted tree shaker having a 20-ft boom, form a single unit that enables harvesting with a minimum of fruit bruising. The catcher-conveyor unit is about 18 ft long, and its canvas conveyor belts are about 6 ft wide.

On the tree side of each section, two movable hinge-mounted flaps about 1½ ft wide are positioned by operators to slant toward the conveyor belts. The flaps, constructed of light steel tubing covered with canvas, are shaped to fit part of each way around a tree trunk. A similar flap, about 4 ft wide, is on the outside of each section.

After a tree is shaken, fruit caught in the flaps rolls onto the slowly moving conveyors and moves to boxes at the rear of the belts. Controls for moving, steering, positioning, and operating the conveyor belts are within easy reach of the operator, who walks behind the machine. The catcher-conveyor unit is powered by a 3 hp gasoline engine.

Paul A. Adrian, agricultural engineer of USDA's Agricultural Research Service at Davis, Calif., designed the new machine, aided by Robert B. Fridley, California Agricultural Experiment Station engineer. A private concern furnished materials and constructed a full-sized experimental machine for the engineers to test.

Blacklight Traps Proving Worth

Insect traps that attract several night-flying pests by means of near-ultraviolet fluorescent blacklight lamps are proving their worth from coast to coast. The traps are used by Federal-State entomologists in determining crop-damaging insect infestations and the need to establish means of control.

The traps were developed by engineers of USDA's Agricultural Research Service in cooperation with the Purdue University, Texas, and Virginia Agricultural Experiment Stations. The traps have been field tested and improved since 1952.

Effectiveness of the traps was demonstrated last year in locating infestations of the grassland-destroying European chafer beetle at Phelps, N. Y. Up to 70 times more adult beetles were taken in the light traps than in chemically baited traps.

From August through October last year, 170 light traps equipped with argon-glow lamps were used in Arizona, Nevada, California, and northwestern Mexico to detect pink bollworm moths and aid in the prevention of further spread of this cotton pest.

Insects captured in the traps include cutworm, armyworm, forage looper, tobacco budworm, and tobacco hornworm moths; yellow-striped armyworm, seed-corn and sugarcane beetles, and seed-corn maggot flies.

NEAPCO
UNIVERSAL JOINTS & DRIVE SHAFTS
Telescoping Drive Lines.
Safety Shielded, and Safety Clutch Assemblies.
Quick Disconnect for standard or 1000 RPM.
Single Universal Joints.
YOUR COMPLETE SOURCE
NEAPCO has *in production* a complete range of sizes to meet most design specifications . . . whether your needs are for light duty steering and control applications or heavy duty tractor PTO drives in standard or new 1000 RPM speeds.
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To help solve your universal joint and drive shaft problems NEAPCO offers complete production facilities, engineering services. Many leading manufacturers now specify NEAPCO. May we also have the opportunity to work with YOU?
WRITE FOR ENGINEERING LITERATURE
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NEAPCO PRODUCTS, INC., POTTSTOWN, PENNSYLVANIA, U. S. A.

Resource Training for Business, Industry, Government. Cloth, 5¾ x 8¾ inches, ix+159 pages, indexed and illustrated. Published by the Conservation Foundation, 30 East 40th St., New York, N. Y.

This book is written to present the thinking of a number of people concerned with conservation and conservation education. It attempts to give concrete and vivid answers to the questions, Where does resource training stand today? How did it get there? Where is it heading in the future? It is intended to give its readers some understanding of the problems involved in a modern approach to conservation and conservation education, and of the way workers in the field are currently attacking these problems.

Land Consolidation in Europe, 3/E (English) prepared by Erich H. Jacoby. Paper, 9½ x 6¾ inches, 142 pages, indexed and illustrated. Contains two separate colored maps illustrating re-allocation of land in Recologne (Doubs), France, and Albis, Switzerland. Published by H. Veenman & Zonen N. V., Wageningen, The Netherlands.

Part I of the publication contains material on economic and social aspects of land consolidation and the improvement of the agrarian structure; Part II covers legislation, financing and administration; Part III is on technical aspects of land consolidation, and Part IV discusses agrarian reconstruction as a current responsibility.

The study is based upon the work of the working party on consolidation of holdings organized under the Sub-commission on land and water use of the European Commission on Agriculture—F.A.O.

Proceedings of the Seventh Annual National Dairy Engineering Conference, Michigan State University, East Lansing. Paper, 11 x 8½ inches. Indexed. Copies of this and former proceedings are on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y. Nominal Cost.

Papers included contain discussions on how management can reduce costs, ice cream plant labor efficiency studies, engineering management, new conveyor developments, systems and equipment for dispenser cans—washers, systems and equipment for dispenser cans—fillers and systems, making canned concentrated milk, new ideas in evaporators and dryers, why a three-tube freezer—and its operation, new developments in equipment for casing of bottles and cartons, will liquid ammonia positive circulation refrigeration systems improve your plant?, recent developments in automatic cleaning of storage tanks, field experiences with air-operated valves, what we'd do differently (panel), ultra-high temperature processes, what's new in packaging cottage cheese and ice cream, overhead conveyors in hardening rooms, looking ahead in the dairy equipment business, and the dairy industry in the Soviet Union—1958.

Creep of Engineering Materials, by Iain Finnie and William R. Heller. Cloth, 9¼ x 6¼ inches, ix+341 pages, illustrated and indexed. Published by McGraw-Hill

(Continued on page 364)

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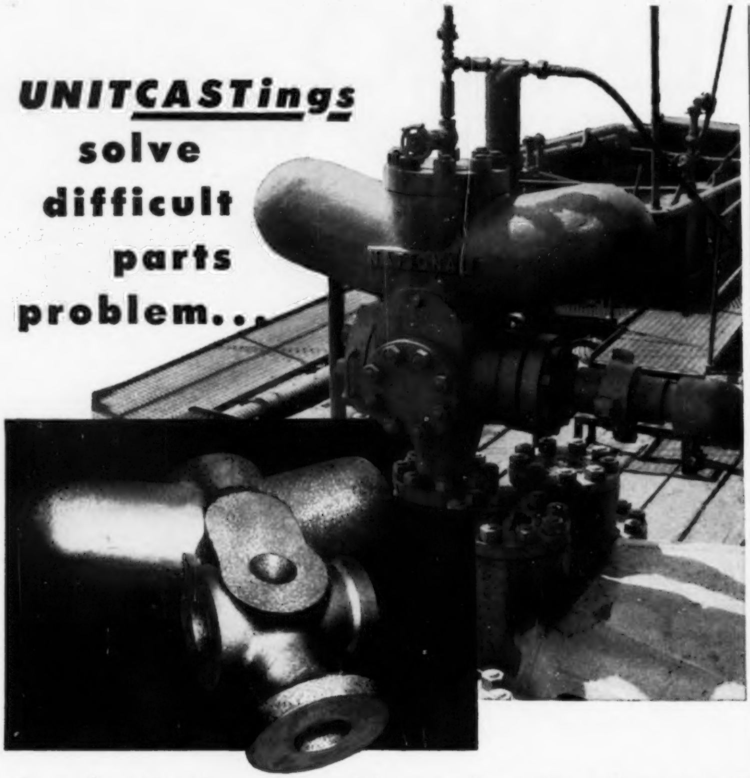

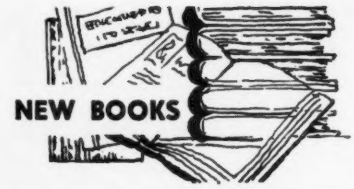

Resource Training for Business, Industry, Government. Cloth, 5¾ x 8¾ inches, ix+159 pages, indexed and illustrated. Published by the Conservation Foundation, 30 East 40th St., New York, N. Y.

This book is written to present the thinking of a number of people concerned with conservation and conservation education. It attempts to give concrete and vivid answers to the questions, Where does resource training stand today? How did it get there? Where is it heading in the future? It is intended to give its readers some understanding of the problems involved in a modern approach to conservation and conservation education, and of the way workers in the field are currently attacking these problems.

Land Consolidation in Europe, 3/E (English) prepared by Erich H. Jacoby. Paper, 9½ x 6¾ inches, 142 pages, indexed and illustrated. Contains two separate colored maps illustrating re-allocation of land in Recologne (Doubs), France, and Albis, Switzerland. Published by H. Veenman & Zonen N. V., Wageningen, The Netherlands.

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(Continued on page 364)

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PERSONNEL SERVICE BULLETIN

Note: In this bulletin, the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service Listing.

Positions Open – 1958 – **November** – O-331-835, **December**–O-352-839, 349-841, 349-842, 362-844. 1959 – **January** – O-418-845. **February** – O-13-901. **March**–O-38-903, 39-904, 41-905, 45-906, 45-907. **April**–O-50-908, 55-909, 58-910, 56-911, 59-912, 71-913. **May** – O-77-914, 49-915, 42-916, 95-917, 66-918, 97-919.

Positions Wanted–1958–**November**–W-332-55, 324-56, 339-59, 318-60. **December** – W-347-61, 345-62, 346-63, 358-64, 363-65, 364-66. 1959 – **January**–W-355-67, 383-68, 411-69, 412-70, 406-71, 419-72, 422-73. **February**–W-9-1, 17-2, 22-3, 23-4, 20-5. **March**–W-25-6, 33-9, 30-10. **April**–W-54-11, 70-12, 72-13. **May** – W-64-14, 83-15, 84-16, 86-17, 67-18, 80-19, 98-20, 99-21, 100-22, 101-23, 102-24.

NEW POSITIONS OPEN

Transmission Design Engineer for major farm equipment manufacturer in Midwest. Age 35-50. Minimum of 10 years design experience on tractor, truck or automotive gear transmissions, including recent experience on semi-automatic and automatic transmissions and torque converter applications. Salary $12,000-$14,000 range. O-124-920

Agricultural Engineer to produce plans for farm service buildings and farmsteads for established farmstead equipment manufacturer in Midwest. Age under 35. BSAE with major in farm structures, or equivalent experience. Dairy farm background preferred. Sales type personality for field work with salesmen. Opportunity to qualify for head of department in a few years. New lines under development. Prefer man with military service requirements completed. Work requires living in or near small town where plant is located. Salary $4,400 or higher. O-129-921

Sales Engineer for application engineering of ball bearings to all types of machinery; selling to purchasing departments and service engineering with shop departments. Kansas City and other locations. Age 30 to 45, not critical. BSME or equivalent. Layout and application experience on bearings. Understanding of machinery. Ability to work with and convince people. Opportunity up to individual. Salary open. O-131-922

Service Engineer, for building products department of major aluminum producer. Western location. Will assist in building product planning and development, for farm and residential fields. Age 23-26. BSAE with major emphasis on farm buildings. Drafting and construction experience helpful but not required. Job requires tact, presentable appearance, capacity for self-expression, and ability to get along with both sales and production people. Travel about 20% of time. Real opportunity with expanding business. Salary $550 per month. O-132-923

Farm Equipment Engineer for design, improvement, and testing of a complete line of hog feeders, fountains, stock tanks and automatic equipment with established manufacturer in Midwest. Age open. Prefer college graduate with farm background and experience in farm equipment design. Must be able to work with sheet metal. Expanding company with advancement possibilities. Salary open. O-111-924

Agricultural Engineer to head crop dryer department of established farm equipment manufacturer in Midwest. Work will include research, design, sales assistance, and contacting agricultural colleges. Age 50 or less. BSAE or BSME, with prior experience in drying. Able to guide, instruct, and get along with others. Excellent opportunities for advancement. Salary open. O-133-925

Agricultural Engineers (one or more) for design and development of structural and mechanical equipment for farm materials handling with established manufacturer in Midwest. Work will include original design, field test, production design, and follow through on pilot run. Age 25-40. BSAE, BSME, or equivalent practical experience. Farm experience desirable. Neat appearance and ability to work with production and sales groups. Must be willing to live in small community. Good opportunity for advancement. Salary open. O-135-926

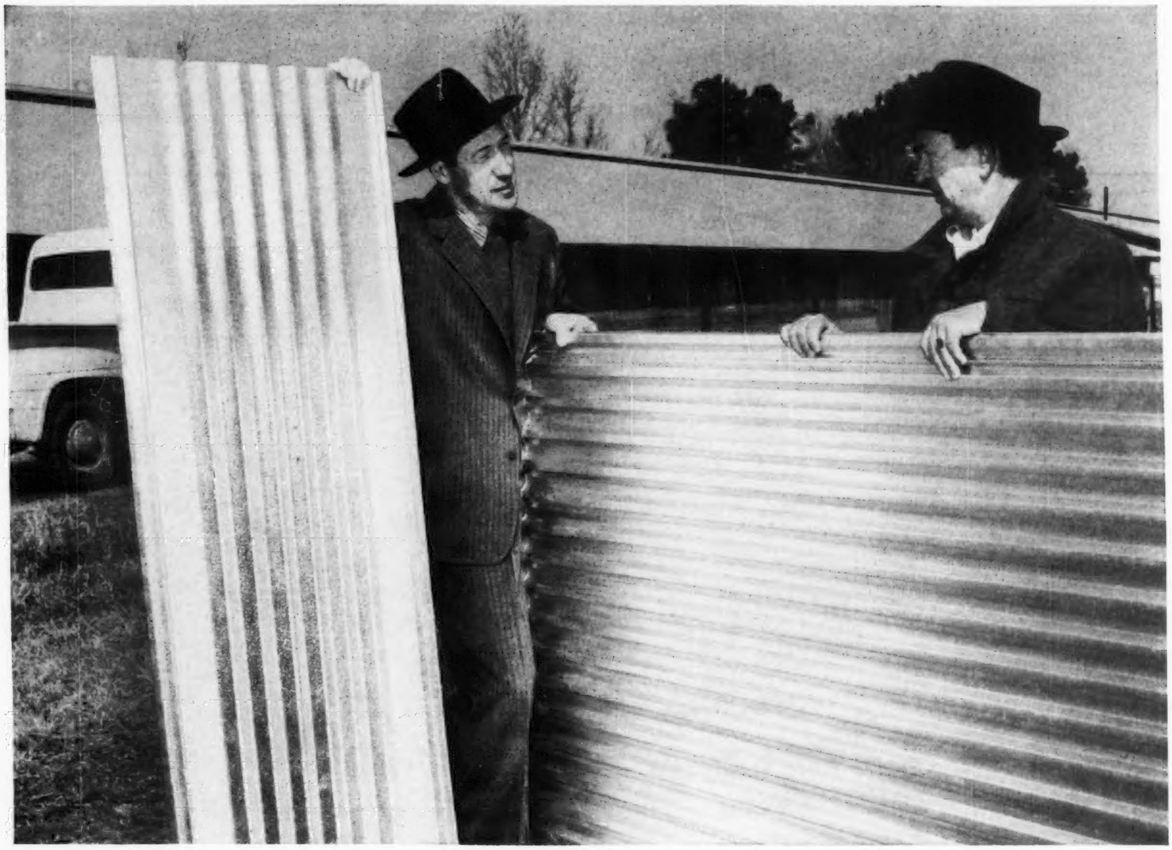
Agricultural Engineer (research associate) to develop and supervise a research program in farm structures and related agricultural engineering problems in a Canadian university. Will also coordinate engineering projects within the faculty of agriculture, and handle some teaching. MSAE preferred. BSAE will be considered. Several years experience in general construction, heating, air conditioning, and lighting. Farm background and some experience in dealing with agricultural problems. Want mature, responsible, alert man who enjoys work with the general public. Normal opportunity for advancement. Salary open. O-136-927

Animal Nutritionist to supervise manufacture of all experimental rations to be fed on research farm for milling laboratory in Midwest. Age 22-38. MS in feed technology, or comparable work experience. Two or more years of milling experience. Must have supervisory and management potential. Company has policy of promotion from within, and liberal pay scale. Salary open. O-137-928

Agricultural Engineer to head farm structures research (75%) and teaching (25%) in a south central state university. Teaching will be in recognized professional curriculum. PhD in agricultural engineering preferred. MSAE acceptable. Teaching and/or research experience desirable. Must be able to work with people and direct student activities. Excellent opportunity for advancement by building a strong farm structures research program and helping direct the professional degree program. Salary $7,000 or higher, depending on qualifications. O-140-929

Agricultural Engineer to head research (75%) and teaching (25%) program in soil and water conservation engineering in a south central state

(Continued on page 364)



FROM ALCOA RESEARCH: TWO IMPROVED ROOFING SHEETS

Two handsome new aluminum roofing sheets incorporating a wide range of improvements are the latest developments of Alcoa agricultural research.

New Alcoa® Rib Roofing is a smart, modern, diamond-embossed roofing sheet equally adaptable to use on pole buildings and for beautifying the homestead. Farm homemakers will be using it for patio shades, utility room panels, carports, basement walls where mildew is a problem, and other related uses.

Technically, Alcoa Rib Roofing is ideal for these multiple uses. It comes $50\frac{3}{4}$ in. wide, lays up full 48 in., is extra-heavy gage, comes in lengths from 6 ft to 16 ft, is finished diamond embossed in attractive, deep, flat-top corrugations with a nonsiphon side lap.

Alcoa Rib Roofing has yield strength of 32,000 psi before embossing; pitch of 2.67 in. with $\frac{9}{16}$-in. depth; weight approximately 33 lb per sq, is designed to withstand uniform loads of 124 lb per sq ft on 24-in. purlins.

This sheet is stronger than .024-in. corrugated, embossed aluminum sheet under uniform loads, will withstand reasonable bending without breaking and is available with a complete line of accessories. It should be fastened with standard Alcoa Aluminum Nails.

New Alcoa 4-V Roofing is a corrugated, embossed roofing sheet which has many improvements over standard V-drain roofing. It has two V crimps on each edge, six corrugations between V's and a nonsiphon side lap. Alcoa 4-V Roofing comes 26 in. wide, lays up 24 in., is available in lengths 6 ft to 12 ft in .019-in. aluminum.

Its design eliminates "oil canning," "fish mouthing" and opening from expansion. It reduces glare, lays with extreme ease and has better nailing characteristics than its predecessor. Alcoa Aluminum Nails should be used. Complete accessories are available.

Alcoa 4-V Roofing has a typical yield strength of 35,000 psi before embossing, uses $\frac{1}{2}$-in. V's, is corrugated $\frac{3}{8}$ in., weighs approximately 29 lb per sq. Use solid deck or nailing strips on 12-in. centers.

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☐ Alcoa Rib Roofing leaflet ☐ Alcoa 4-V Roofing leaflet ☐ One complete set of nine pole-building StePlans* ☐ *Pole Barn Plans Catalog* . . . lists Alcoa plans available to farmers ☐ *Pipelines to Profit*, booklet on portable irrigation ☐ "Right as Rain," 28-min sound-color film on portable irrigation† ☐ "Barn Raising, U.S.A.," 18-min sound-color film on pole-barn construction using aluminum roofing and siding† ☐ Alcoa Farm Gate literature, facts about aluminum gates

*Trademark of Aluminum Company of America.

†Films may be borrowed for public showing. Specify dates wanted.

Name ____________________

Address ____________________

Post Office and State ____________________

. . . Personnel Service

(Continued from page 362)

university. Teaching will be in recognized professional curriculum. PhD in agricultural engineering preferred. MSAE acceptable. Teaching and/or research experience desirable. Must be able to work with people and direct student activities. Excellent opportunity for advancement by building a strong soil and water conservation research program, as well as helping direct the professional degree program. Salary $7,000 or higher, depending on qualifications. O-140-930

NEW POSITIONS WANTED

Agricultural Engineer for extension, teaching, or research in power and machinery, with industry or public service, any location. Married. Age 25. No disability. BSAE, 1957; MSAE expected September 1959, Michigan State University. Dairy farm background. Part-time factory work while in college. Research and teaching experience, while working for MS degree. Available September 7. Salary $6,500 minimum. W-103-25

Agricultural Engineer for research or writing in power and machinery or product processing, with industry or public service. Any location. BSAE, 1955; MSAE expected August 1959, Oklahoma State University. Also BS in meteorology, 1956, Pennsylvania State University. Weather Officer, USAF, 1955-59. Available in August. Salary open. W-104-26

Agricultural Engineer for research assistantship in farm structures or electric power and processing, with college or experiment station. Any location in U.S. or Canada. Single. BSAE, 1958, National Taiwan University. Experience in deep-well drilling, and in teaching science and mathematics. Available on reasonable notice. Salary $3,200-$3,500 range. W-118-27

Agricultural Engineer for design, development or research in farm structures or soil and water field with industry, preferably in Southwest or South. Married. Age 29. No disability. BSAE, 1953, Texas A and M College. Experience 3 years in construction work. Field representative on product improvement with aircraft manufacturer, 6 mo. Available on reasonable notice. Salary open. W-112-28

Agricultural Engineer for design, development, or research in power and machinery, rural electric, or soil and water field with industry. Any location. Single. Age 27. No disability. BSAE expected in August, Southwestern Louisiana Institute. Farm background. Air Force service 4 years. Available in August. Salary open. W-123-29

Agricultural Engineer for sales or service in power and machinery with industry. Any location. Married. Age 29. No disability. BSAE, 1958, Texas Technological College. Farm background. Additional experience as diesel mechanic's helper, 6 months; in farm machinery sales and service, 2 years; with Soil Conservation Service, 1½ years; with U.S. Air Force 4 years, including 18 months as instructor. Available on reasonable notice. Salary $425 per month. W-138-30

. . . New Books

(Continued from page 360)

Book Co., Inc., 330 West 42nd St., New York 36, N. Y. $11.50.

This volume is a comprehensive coverage of the creep of materials, treating design for creep conditions in detail to aid in formulating and solving engineering problems. It combines the basic principles of material behavior with important applications to engineering problems, and supplies clear perspective of the advantages and limitations of different materials which undergo creep. Contains detailed and illustrated treatment of such topics as: creep testing, measurement of creep variables such as temperature, strain, and load; mechanisms involved in the creep of metals and nonmetals; stress analysis under creep conditions; sources of creep data; factors in chosing a design stress; and creep problems which occur in specific applications.

An Introduction to Physical Microclimatology, by F. A. Brooks. Paper, 11 x 8½ inches, ix+264 pages, indexed. Distributed by Associated Student Store, University of California, Davis. $8.35.

This treatise on heat and vapor exchange close to the ground is for those seeking a working knowledge of the thermal relationships between the solar and nocturnal radiation and the resulting equilibrium temperatures in our climatic environment. Chapter headings refer to general climate and weather systems, the atmosphere; radiation; solar, long-wave, and atmospheric; conduction of heat in the ground; eddy transfers, thermal convection; evaporation and transpiration; frost protection, and description of local climate with climatic maps.

The Scientific Principles of Crop Protection, by Hubert Martin, fourth edition. Cloth, 9¼ x 6¼ inches, viii + 359 pages, indexed. Published by Edward Arnold (Publishers) Ltd., 41 Maddox St., London, W. 1.

This book is an expansion of the third edition (1940) and follows the plan of the former edition except that the expansion of knowledge of the mechanisms of toxic action now permits a co-ordinated treatment and a discussion of the general principles prior to their specific application to the several groups of pesticides. It treats with plant resistance, the influence of external factors on the susceptibility and liability of the plant to attack, biological control, fungicides and insecticides, the measurement and mechanics of toxicity, fungicides, insecticides, weedkillers, fumigants, seed treatment, soil treatment, traps, and the treatment of the centres and vectors of infection.

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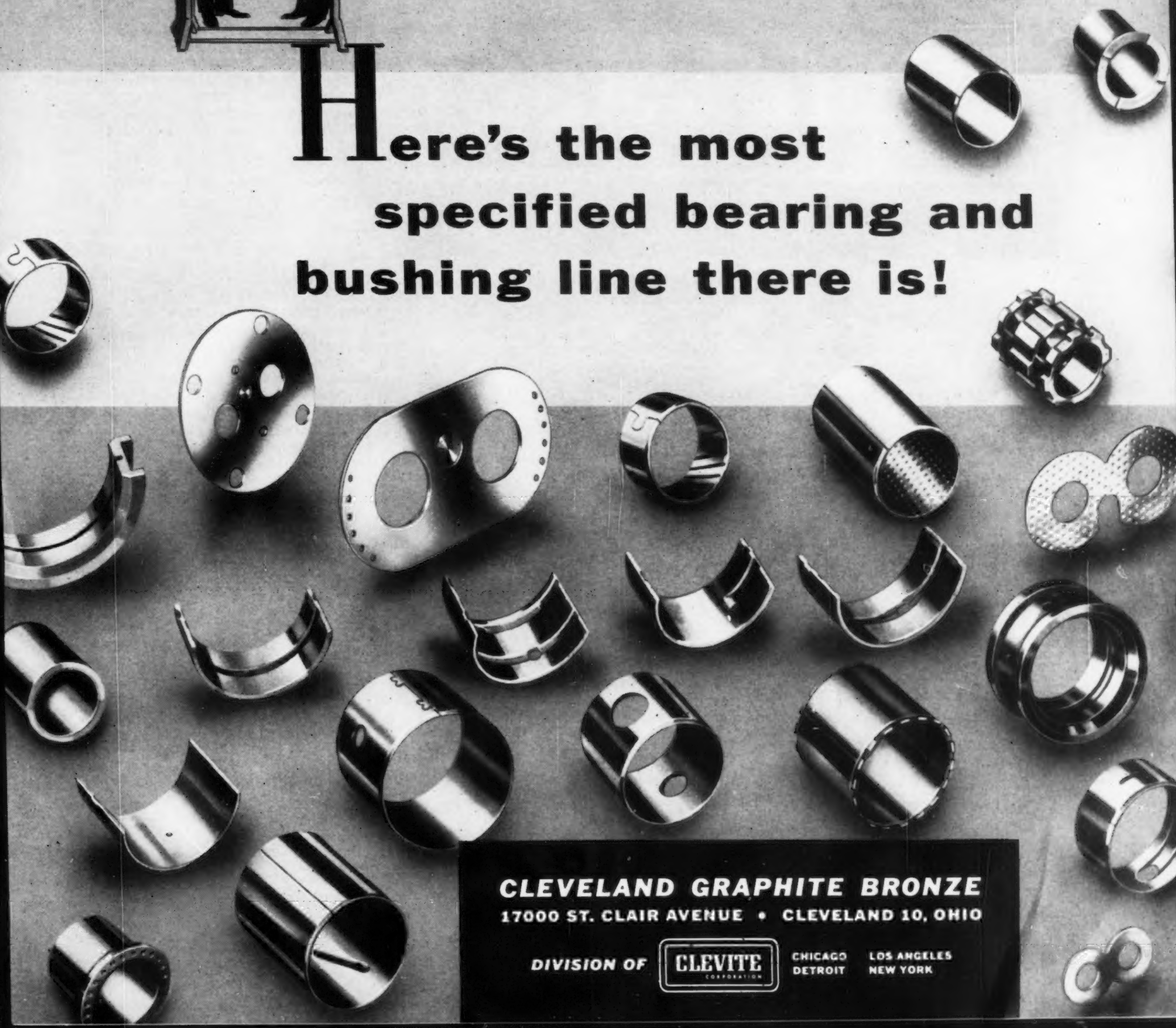

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The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Alberson, David M. — Agr. engr., Southwestern Cotton Ginning Res. Laboratory, USDA. (Mail) R.R. 2, Box 164, Las Cruces, N. M.

Bardwell, Howard F. — Chief product dev. engr., International Harvester Co. (Mail) 950 Biggs St., Memphis 8, Tenn.

Brail, Donald E. — Sales engr., Molded Fiber Glass Body Co., 4601 Benefit Ave., Ashtabula, Ohio

Corry, Jack A. — Jr. engr., dept. of irrigation, Univ. of California, Davis Campus, Davis, Calif.

Dabney, William Y., Jr. — Vice-president, Roberts Mfg., Inc., 4515 Prentice St., Dallas 6, Texas

Daniels, A. W. — Chief engr., Dunbar Kapple Inc. (Mail) 1318 W. State St., Geneva, Ill.

De Quintana, Manuel L.—Ingenieros importadores, Apartado 13, Holguin, Ote., Cuba

Dove, James L. — Agr. engr., SCS, USDA, Box 176, Romney, W. Va.

Essex, Duane A. — Jr. engr., John Deere Des Moines Works. (Mail) 105 Cherry St., Ankeny, Iowa

Hoag, Russell J.—Salesman, Tri-State Culvert and Mfg. Div. (Mail) P.O. Box 327, Melbourne, Fla.

Hughes, John G.—Soil conservator, Waitaki Soil Conservation Committee, P.O. Box 110, Kurow, Otago, New Zealand

Humphries, Ervin G. — Graduate student, North Carolina State College. (Mail) R.R. 4, Shelby, N. C.

Mack, Willard E. — Field engr., sales div., Gates Rubber Co. (Mail) P.O. Box 206, Davenport, Iowa

McQuitty, James B.—County agr. advisory officer, North Ireland Ministry of Agr. (Mail) 200 Malone Road, Belfast, North Ireland

Mehrotra, Rajendra N. — Foreman, agr. eng. workshop, Gwalior. (Mail) Roopjyoti—behind Janakganj Kotwali, Gwalior, India

Morris, Albert L., Jr. — Assoc. editor, southeast edition, Electricity On the Farm Magazine. (Mail) 2535 Layton Dr., Lithonia, Ga.

Sauter, Norman A.—Mgr., materials eng. dept., chemical, lubrication and paint div., Deere & Co., 1325 Third Ave., Moline, Ill.

Schairer, Dale H. — Graduate asst., agr. eng. dept., Michigan State Univ. (Mail) 1648 Snyder Road, East Lansing, Mich.

Schaper, Laurence T. — Jr. engr., Kansas Water Resources Board. (Mail) 1508 Topeka St., Topeka, Kans.

Smith, Charles H. — Owner, C. H. Smith and Partner, consultants, 42a High St., Dunmow, Essex, England

Taylor, Donaldson S. — Farm power advisor, Pacific Gas & Electric Co., P.O. Bin 319, Bakersfield, Calif.

Thomas, Robert L. — Agr. application engr., The Fafnir Bearing Co. (Mail) 39 Vance St., New Britain, Conn.

Vogelaar, Bernard F.—Div. head, John Deere Harvester Works (Mail) 1710 36th St., Moline, Ill.

TRANSFER OF MEMBERSHIP

Bonnicksen, LeRoy W. — Asst. prof. of agr. eng., agr. eng. dept., Oregon State College, Corvallis, Ore. (Associate Member to Member)

Hoyt, C. Thomas — Product des. engr., Brillion Iron Works, Inc. (Mail) P.O. Box 155, Brillion, Wis. (Associate Member to Member)

McKenzie, Bruce A. — Ext. agr. engr., agr. eng. dept., Purdue Univ., Lafayette, Ind. (Associate Member to Member)

STUDENT MEMBER TRANSFERS

Auchstetter, Henry J. — (University of Illinois) (Mail) R.R. 1, Mendota, Ill.

Bricher, Charles W. — (University of Minnesota) (Mail) 531 Raymond Ave., St. Paul 4, Minn.

Doering, James P. — (University of Wisconsin) (Mail) 126 S. College Ave., Geneseo, Ill.

Fisher, Ivan E. — (South Dakota State College) (Mail) Amherst, S. D.

Fryrear, Donald W. — (Colorado State University) Agr. engr., ARS, USDA, Akron, Colo.

Hahn, Russell H., Jr. — (Ohio State University) (Mail) R.R. 2, Burgett Rd., Canfield, Ohio

Hamborg, Jon T. — Room 5520, Niles-Friley Hall, Iowa State College, Ames, Iowa

Hoopes, Francis S. — (Kansas State College) (Mail) 601 Court St., Scott City, Kans.

Johnson, David C. — (University of Illinois) (Mail) R.R. 1, Cherry Valley, Ill.

Kopitzke, Herman W., Jr. — (Montana State College) (Mail) Culbertson, Mont.

Law, Troy A. — Agr. eng. dept., Virginia Polytechnic Institute, Blacksburg, Va.

Lawrence, Stanley L. — (University of Vermont) Massey-Ferguson Co. (Mail) 12087 Monica Ave., Detroit, Mich.

Leaverton, Erwin D.—(Oklahoma State University) (Mail) 1544 N. Oswego, Tulsa, Okla.

Leitz, Franklin W.—(State College of Washington) (Mail) R.R. 2, Fairfield, Wash.

Miller, Clayton R. — (Iowa State College) (Mail) 263 N. Hyland Ave., Ames, Iowa

Morgan, John W.—(State College of Washington) (Mail) R.R. 2, Colfax, Wash.

Neumann, Edmund C.—(Iowa State College) (Mail) 407 Welch Ave., Ames, Iowa

O'Connor, John W.—(University of Wisconsin) (Mail) R.R. 3, Mineral Point, Wis.

Packard, Charles E.—(Iowa State College) (Mail) 1303 Washington, Cedar Falls, Iowa

Paff, Richard H.—Dept. of agr. eng., Pennsylvania State University, University Park, Pa.

Peters, Carl T.—Dept. of agr. eng., University of Arkansas, Fayetteville, Ark.

Petersen, Dale R.—Dept. of agr. eng., State College of Washington, Pullman, Wash.

Pfost, Donald L.—(University of Missouri) (Mail) 906 W. Ash, Columbia, Mo.

Purdy, Daniel M. — (Iowa State College) (Mail) 115 Lynn, Ames, Iowa

Raju, Siruvuri R. — Agr. eng. dept., Virginia Polytechnic Institute, Blacksburg, Va.

Schmidt, Edward D., Jr. — (University of Georgia) (Mail) 54 Pocono Ave., Yonkers, N. Y.

Schoof, Richard L. — (Kansas State College) Forestry Service. (Mail) 107 Velie St., Council Grove, Kans.

Schott, Wilbur W. — (Ohio State University) (Mail) 3352 Coolidge Hwy., Royal Oak, Mich.

Schuetz, Frederick H. — (Pennsylvania State University) SCS, 100 N. Cameron St., Harrisburg, Pa.

Shepard, Jack H. — (Alabama Polytechnic Institute) (Mail) Covington Planter Co., Dotham, Ala.

Smith, Edgar H.—(Pennsylvania State University) Eng. dept., New Holland Machine Co., New Holland, Pa.

Spinks, Jack M. — (A. and M. College of Texas) (Mail) 401-A First St., College Station, Texas

Spooner, Neale L. — (North Dakota Agricultural College) (Mail) Noonan, N. D.

Sveum, David L. — (South Dakota State College) (Mail) 1340 Third St., Brookings, South Dakota

Swanson, Lee V. — (Iowa State College) (Mail) 815 Carroll Ave., Ames, Iowa

Tabb, John D.—(Colorado State University) (Mail) P.O. Box 207, Hayden, Colo.

Teaford, William J.—(Kansas State College) Farm Equipment Eng. and Res. Center, International Harvester Co., 7 So. 600 County Line Rd., Hinsdale, Ill.

Waddington, Ralph E. — (University of Nebraska) SCS, McCook, Nebr.

Watson, Wilmer E. — (Purdue University) (Mail) Battle Ground, Ind.

Webber, Peter A.—(University of Maine) (Mail) 36 Willow St., South Portland, Me.

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Zimmerman, Arnold—(University of Wisconsin) (Mail) 233 N. Catherine, LaGrange, Ill.

Zobrist, Frederick A. — (State College of Washington) (Mail) 1820 164th St., S.W., Alderwood Manor, Wash.

. . . Manufacturers' Literature

(Continued from page 357)

Aluminum Bulletin

The Aluminum Association, 420 Lexington Ave., New York 17, N. Y. — The Aluminum Bulletin is a quarterly publication of the association and an informative booklet for technical and administrative readers in the metal-consuming fields. In the current Winter 1958-1959 issue is an interesting article "Aluminum for Farm Efficiency" and the editorial "How Big Is a Country?"

Scrapers for Soil-Moving Jobs

The Farmhand Company, Hopkins, Minn. — Soil movers for farm work, soil conservation, landscaping, irrigation, road maintenance and industrial jobs are described in an 8-page, 4-color bulletin. Various models are illustrated by photographs and specifications are also included.

Vinyl Wrinkle Finishes

Union Carbide Plastics Co., Div. of Union Carbide Corp., 30 East 42nd St., New York 17, N. Y. — Designated as Coatings Technical Release No. 40, the 5-page bulletin describes the use of vinyl plastisols. organsols and solutions in the formulation of vinyl wrinkle castings. Explanations of suggested formulations of using plastisols, organosols and solution coatings in preparing vinyl wrinkle finishes are also included.

Index to Advertisers

ADVERTISING REPRESENTATIVES

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San Francisco 5 — McDONALD-THOMPSON, 625 Market St. YUkon 6-0647

Los Angeles 5 — McDONALD-THOMPSON, 3727 W. Sixth St. DUnkirk 7-5391

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Tulsa 4 — McDONALD-THOMPSON, 2010 South Utica. RIverside 3-1981

Phoenix — McDONALD-THOMPSON, 541 West Claremont. CRestwood 4-1342

Advertising Manager: RAYMOND OLNEY, 420 Main St., St. Joseph, Mich. YUkon 3-2700

GRAIN OF ALL KINDS is steadily and efficiently conveyed, distributed, and collected by Link-Belt augers on this 458 portable grain dryer manufactured by John Deere, Moline, Ill.

LATEST MACHINES AND METHODS assure auger accuracy. Tubing is jig punched . . . rolled to be true round. Flighting is cold rolled for slip fit on tubing, welded for permanent alignment.

These LINK-BELT auger differences make a

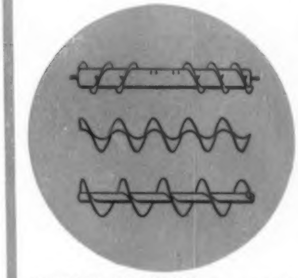
big difference to designers

They mean smoother working equipment ... less work for you

You can work Link-Belt augers into your design easily . . . confidently. They're available in diameters, gauges and pitches to match any need. And each offers a combination of simplicity, strength and precision that assures lasting efficiency.

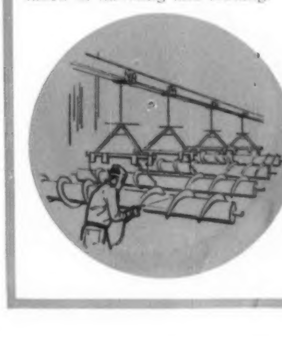
Every Link-Belt auger is uniform, smooth, accurately rolled . . . one compact basic assembly fabricated to meet your requirements. Only selected steels are used and Link-Belt's specialized machinery assures consistent flighting uniformity.

Whatever your project—a new application for your present machine or an entirely new concept—simplify your design problems by specifying Link-Belt augers. For full details, call your nearest Link-Belt office. Ask for Book 2289 . . . industry's most complete auger catalog.



SELECTED FLIGHTING is available from Link-Belt for every auger need — helicoid, cut flight, short pitch, ribbon flight, double flight and many others — in the metal and finish best suited for your design.

QUALITY "SAFEGUARDS" protect precision of Link-Belt augers. Straightness is carefully checked before shipping . . . painting prevents rusting . . . extra care is taken in handling and loading.



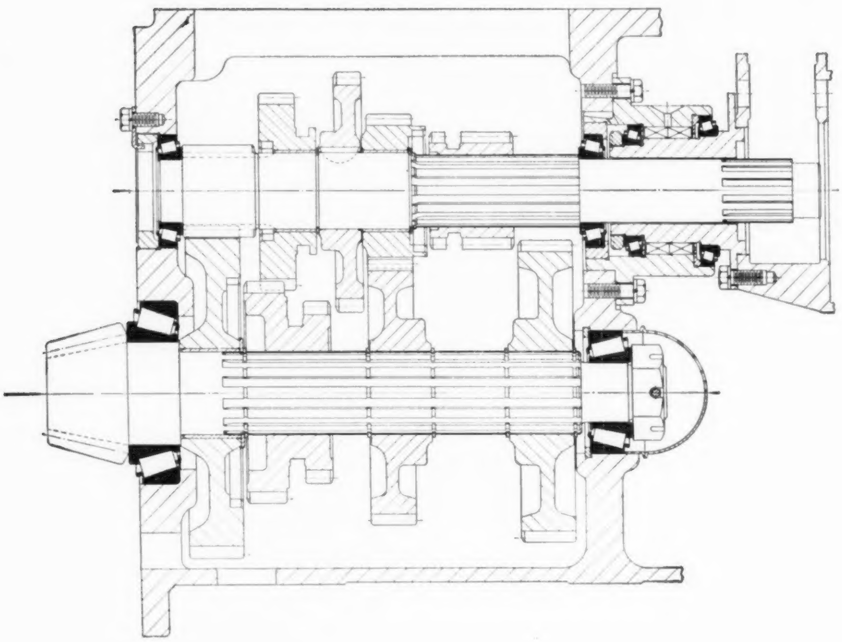
LINK-BELT

FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,930

Highest capacity at lowest cost in new Minneapolis-Moline tractor transmission

Timken® bearings simplify gear reduction unit, give greater rigidity for longer life



WITH a simpler design, Minneapolis-Moline engineers achieved high capacity for the transmission of their new MM 5-Star tractor. And they did it at lowest possible cost by using Timken® tapered roller bearings in the gear reduction unit.

Using Timken bearings enabled them to apply the effective spread principle at the bevel pinion. The design of the bearing at this point is such that the effective center of the bearing's load-carrying capacity is close to the bevel pinion center line, providing the ultimate in rigidity at this vital point. Throughout the transmission, Timken bearings assure maximum rigidity, keep all gears in alignment under rugged farm working conditions. No other bearings can give equal capacity at the price.

Simpler and more compact designs are big reasons why more and more engineers are standardizing on Timken bearings for rugged farm machinery. Full-line contact between rollers and races gives Timken bearings extra load-carrying capacity. Timken bearings keep shafts concentric with their housings—make closures more effective. Dirt stays out; lubricant stays in. And because Timken bearings practically eliminate friction, they save power and cut fuel consumption.

Agricultural engineers find answers to three big problems with Timken tapered roller bearings: 1) Combination loads; 2) dirt; 3) ease of operation. Timken bearings are a precision product—both by design and manufacture. We even make our own steel. No other American bearing manufacturer does.

For help in designing new bearing applications, contact our sales engineers or write to The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER
BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

The farmer's assurance of better design

Tapered Roller TIMKEN BEARING EQUIPPED